Quality Misallocation, Trade, and Regulations*

Luca Macedoni[†]
Aarhus University

Ariel Weinberger[‡]
George Washington University

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Abstract

This paper incorporates product standard regulations into a multi-country general equilibrium framework with firm heterogeneity and variable markups. We model regulations as a fixed cost that any firm selling to an economy must pay, consistent with stylized facts that we present. The fixed cost can improve allocative efficiency by reallocating production towards high-quality firms, who under-produce in the market allocation, and away from low-quality firms least able to bear compliance costs. Importantly, the fixed cost generates a positive externality on the rest of the world as it induces entry of high-quality firms, and it improves the terms of trade of the non-imposing countries. Because of this positive externality, given a level of market access, governments do not choose domestic standards efficiently. The result justifies international cooperation based on the fact that such cooperation can improve welfare. We estimate our model and apply its gravity formulation to quantify the global welfare consequences of altering regulatory policies, the extent of the positive externalities across countries, the effects of cooperation, and the comparison with further tariff liberalization.

Keywords: Allocative Efficiency, Regulations, Quality Standards, Variable Markups, Trade Policy.

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[†]Address: Department of Economics and Business Economics, Aarhus University, Fuglesangs Allé 4, 8210 Aarhus V., Denmark. E-mail: lmacedoni@econ.au.dk. Financial support from the Carlsberg Foundation is gratefully acknowledged.

[‡]Address: Department of International Business, George Washington University. 2201 G St NW, Washington, DC 20052. E-mail: aweinberger@gwu.edu

1 Introduction

Trade agreements and institutions that promote cooperation in international trade such as the WTO are generally justified as a tool to address negative externalities that arise with trade policies (Bagwell and Staiger, 1999; Ossa, 2011). For instance, since an import tariff allows a country to improve its terms of trade at the expenses of its trade partners, the goal of international cooperation is to prevent costly tariff wars. Recent trade agreements have mainly shifted their focus to non-tariff barriers such as regulations and product standards, which have been traditionally treated as pure domestic policies.[1] For instance, in the agricultural and food industry, standards at various stages of the supply chain have the goal to protect consumers. Still, international cooperation in setting these standards has been justified on the basis of misaligned incentives such as delocation effects (Grossman et al., 2021), or to avoid murky protectionism (Baldwin et al., 2000). This paper examines the role of allocative inefficiency in the justification of negotiations over product regulations, and finds a novel role for international cooperation.

As an example, consider regulations over the minimum residue levels (MRLs) of pesticides allowed in food products. Under WTO rules, MRLs are non-discriminatory and apply to all firms selling to an economy, regardless of their origin. The compliance to stricter MRLs requires the payment of a fixed cost of production, which deters entry of the smallest firms, which are less willing to bear the fixed cost (Ferro et al., 2015).[2] As a result, stricter regulations reallocate production towards the larger firms, which are able to sustain the higher fixed costs. This reallocation not only affects welfare in the imposing country, but in its trading partners as well. A goal of this paper is to quantify the incentives for international cooperation of domestic policies when their economies are distorted, providing a practical framework to analyze standards when market access is established.

In the presence of a production misallocation whereby the high-quality firms – e.g. ones that successfully limit pesticide residues – also enjoy higher market power, regulations can improve welfare by raising the allocative efficiency (leaving aside the environmental externalities rationale for now). This must be balanced against the welfare losses due to the payment of the fixed costs. Unlike in the case of import tariffs, which are also incorporated into the framework, we show that higher standards also improve the welfare of *trade partners* as well. For instance, as stricter MRLs in one country raise the average markups and profits of the

[1]Regulations on goods' characteristics are an important tool applied by policy makers. For example, standardization of technical requirements for products is a major priority of the European Commission growth, see: https://ec.europa.eu/growth/single-market/european-standards_en.

[2]As an example of the fixed cost generated by regulations, consider the costs associated with inspections. For instance, in order to export prosciutto from Italy to the US, Italian producers must fly in US inspectors that can certify the compliance to all US regulations.

surviving firms, they also foster the entry of new firms, attracted by the higher profitability. The effects of the increased product variety on foreign consumers are not internalized by the imposing country, which implies that without cooperation, governments *do not* choose an efficient level of domestic standards. This is in contrast to the well-known result in Bagwell and Staiger (2001). Therefore, the paper justifies cooperation on standards on the basis of a positive externality.[3]

Prior to laying out the theoretical results on optimal regulation, we introduce stylized facts that are rationalized by the model. We merge a database of product standards reported as non-tariff measures across 70 countries (NTM-MAP) with information on firm export success from the Exporter Dynamics Database (EDD).[4] Export outcomes, as a real measure of their restrictiveness, suggest that quality standards in trade act primarily as a fixed cost. An origin-sector pair sends fewer exporters to destinations with higher number of regulations (extensive margin), but the average value per exporter (intensive margin) is not affected. This is in contrast to the standard measures of variable trade costs the literature has examined, such as distance, where both margins decline in the trade costs. We therefore interpret more restrictive regulations as a reallocation of production from exiting small firms towards large firms, as is also documented in Fontagné et al. (2015), Ferro et al. (2015), Asprilla et al. (2019), and Augier et al. (2021). Furthermore, we show that destinations with larger income and size tend to apply stricter regulations as they are more successful in restricting market access, while more open economies apply more lenient regulations.

Our theory applies the demand framework of Macedoni and Weinberger (2022), which features variable markups, to a multi-country world with trade frictions. The model features firm heterogeneity and monopolistic competition. Any country can set a regulation that requires all firms selling to it the payment of a fixed cost. The ability to pay these fixed costs will depend on the ex-ante profitability of the firm, which in our model is determined by its quality as the result of a random draw from a distribution (Kugler and Verhoogen, 2012). The effect of the regulation is to select out the lowest quality firms, which for example might be firms whose products are most likely to be unsafe.[5] In order to highlight the welfare

[3] A related question is whether an alternative mix of policies, for example a set of firm-specific taxes and subsidies, might also eliminate distortions. However, these do not improve the welfare of trading partners through the entry margin. To be clear, our goal is not to identify an optimal set of polices based on a sufficient set of policy instruments, but to take as given traditional instruments such as tariffs and analyze the resulting implication for setting domestic standards in a heterogeneous firm model.

[4] Although the model-implied estimated level of restrictiveness accounts for any policies that affect the observed distribution of exporters to a destination, technical measures such as phytosanitary and sanitary (SPS) and technical barriers (TBT) represent a subset of such policies that can be quantified explicitly in the NTM-MAP data.

[5] The model uses a general "quality" for the firm that encompasses any (single) dimension through which quality is determined for a product. As discussed in Macedoni and Weinberger (2022), a model with pro-

difference between regulations and traditional policy tools, our model allows each country to impose import tariffs.

Regulations generate both a reallocation of production that improves the allocative efficiency of a distorted market as well as countervailing effects such as loss of variety and wasteful fixed costs. We stress that our model does not impose an ad-hoc negative externality (e.g. health concerns from high levels of pesticide residues), although we acknowledge standards that raise fixed costs are plausibly imposed for these reasons. The distortion we capture is the over/under allocation of a certain quality level. Our reasoning is that regulations can be used to address several types of externalities – difficult to quantify with one functional form – with a common implication that the smallest firms drop out. In allowing a flexible fixed cost, we identify the novel reallocation and entry effects that occur regardless of the motivation for imposition of standards but are absent in previous analysis. Any improvement on consumption externalities would be a *further* rationale for the standard.[6]

An important result of the paper is to show that stricter domestic regulations not only alter domestic welfare, but they can also have a positive effect on foreign countries. This effect is driven by two channels. First, regulations also affect the relative wage, which reflects changes in the terms of trade. The fixed labor requirement of the regulations requires workers to be employed in this "wasteful" process. As the output produced declines so does the relative purchasing power. This, in turn, benefits foreign consumers. Furthermore, stricter regulations in one country foster the entry of new (high-quality) firms from both the imposing *and* the foreign countries. The increase in the mass of firms is driven by the larger profitability of surviving firms because larger firms earn higher markups.

When setting the optimal restrictiveness in a non-cooperative way, a country does not internalize the benefits to foreign countries, which are driven by the reduction in the relative wage of the imposing country and by the new product variety. The presence of this positive externality on foreign economies motivates international cooperation in setting regulations – a cooperative equilibrium ensures higher welfare with higher levels of regulation.[7] This novel result is in contrast to the beggar-thy-neighbor rationales that dominate much of trade policy (Gros, 1987; Ossa, 2011).

ductivity heterogeneity where costs increase with quality generates similar results.

[6] An extension to the baseline model includes an explicit externality as in Mei (2021), associated with the consumption of goods of higher quality (Appendix 6.5). The results of our paper are robust to this extension.

[7] The result provides a theoretical justification for the continuous efforts from the WTO of improving the Technical Barriers to Trade Agreement, which has now reached the Eighth Triennial Review (see https://www.wto.org/english/tratop_e/tbt_e/tbt_triennial_reviews_e.htm). The logic is also similar to the justification of Trade-Related Aspects of Intellectual Property Rights (TRIPs), approved in the Uruguay Round, brought forward by Grossman and Lai (2004). Protecting intellectual property creates a positive externality in foreign countries, as they can also benefit from increased innovation. As such, agreements on standards of protection for intellectual properties are justified by a positive externality.

Our model also sheds light on why countries may raise objections to regulations of a partner that are deemed protectionist. In our framework, the same level of (non-discriminatory) fixed cost is perceived more stringent in origin countries with a lower average quality. Relatedly, we also rationalize differences in the restrictiveness of regulations across destination countries. We find that larger countries, countries with more efficient production technologies, and more closed economies, will optimally choose to set more restrictive standards, as these countries can tolerate higher levels of fixed costs. This suggests for example that the European Union will likely set stricter standards than Mexico. This is an important result because it arises in the absence of any protectionist motives nor presence of negative consumption externalities nor heterogeneity in preferences.

We provide a quantitative exercise to estimate the current restrictiveness of regulations in the EDD sample of countries and answer the following questions. What are the welfare effects of setting optimal standards independently? How big is the externality identified in the theory? How beneficial is cooperation? We use data on the distribution of firm-level export sales at the country-pair level, which allows us to estimate the level of restrictiveness applied by destinations on individual trade partners. Consistent with our theoretical framework, the estimated restrictiveness acts as a fixed cost as it is negatively related with the extensive margin of exports but positively related with the intensive margin. Furthermore, the framework generates a gravity formulation that we leverage to estimate the global welfare response to a counterfactual change in regulations in either a single or all countries.

As pointed out in the model, countries can raise their own welfare up to a point with a modest level of regulations, but they raise the welfare of their trade partners *always*. Relative to the welfare gains when countries change their standards individually, the gains when *all* countries impose optimal standards is 3 times larger. More open countries, with lower optimal restrictiveness, gain the least from imposing their own optimal regulations, but gain the most from other countries imposing regulations. We compare the welfare effects of regulations to those of tariffs finding that, relative to the current policy, for the majority of countries there is a larger possible gain from a coordinated standards policy than from a global elimination of all tariffs from their current levels.

Lastly, we highlight the large benefits available from cooperation in a case where countries *jointly* set standards. We consider the realistic case of two countries, Chile and Ecuador, and compare their optimal standards and welfare under unilateral policy decisions and under a cooperative solution in which aggregate welfare is maximized. In this setting, a "deep" trade agreement is relatively plausible. Cooperation raises the optimal standard, which remains heterogeneous across the two countries. Hence, welfare maximization does not require setting the same standard in the two countries. Cooperation also raises welfare of both countries.

Related Literature. Quality standards could be raised to address negative externalities, such as environmental externalities (Parenti and Vannoorenberghe, 2019; Mei, 2021), informational asymmetries (Donnenfeld et al., 1985; Disdier et al., 2020; Macedoni, 2022), to reduce oligopolists' market power (Baldwin et al., 2000), or to enhance investments in quality upgrading (Gaigné and Larue, 2016a,b). Technical measures could also be used as murky protectionism (Baldwin and Evenett, 2009), as studied by Fischer and Serra (2000) in the context of an international duopoly. Macedoni and Weinberger (2022) show that the reduction in the misallocation distortion is a further benefit of regulations, even though these are typically imposed to correct more specific negative externalities. This paper acts as a complement to the existing literature as it is the first to explore the interaction between trade openness, regulations, and inefficient markets.[8] A parallel literature investigates the role of standards in trade agreements through the positive impact that harmonization has on trade flows.[9] While our paper takes as given the (fixed) costs involved with imposing standards, harmonization, or mutual recognition, plausibly allows countries to reduce these compliance costs.

A closely related paper is Grossman et al. (2021), which investigates the efficiency of trade agreements in a setting where countries have heterogeneous preferences for regulations and firms pay fixed costs to appeal to different tastes. Without consumption externalities, mutual recognition is necessary to commit countries not to impose standards purely for firm delocation purposes. In our paper, characteristics such as economic size and openness imply divergent regulations even with homogeneous preferences. We complement their work in introducing a separate rationale for regulations and show that when countries share a positive externality, cooperation on setting standards raises efficiency.

We also relate to Campolmi et al. (2014, 2020) as well as Lashkaripour and Lugovskyy (2021), which justify deep trade agreements as a mechanism to improve allocative efficiency through industrial policies. Deep trade agreements refer to those that cover domestic policies as well as traditional import barriers (i.e., tariffs). In these papers, allocative inefficiency is driven by markup heterogeneity *across sectors*, and not across firms within a sector, which is the focus of this paper. In these papers, inefficient allocation of production across sectors

[8]As inefficient markets are a pervasive feature of international trade models, our case for regulation is immune to the criticism where an imposition of a negative consumption externality could be considered ad-hoc. Furthermore, negative consumption externalities are hard to quantify, which makes a welfare comparison between private solutions and a centralized government solution difficult to examine concretely.

[9]Swann et al. (1996) find that standards raise exports for UK firms. Chen and Mattoo (2008) find that trade flows increase with EU/EFTA harmonization. Shmidt and Steingress (2018) confirm the rise in export flows, at the intensive and extensive margin, across a broad set of standards and across countries. Parenti and Vannoorenberghe (2019) motivate the emergence of trade blocks through the incentive to harmonize depending on the "regulatory distance" between trade partners.

can be improved upon with subsidies, to be internationally coordinated along with tariffs. The aim of our paper is quite distinct – it is not to find an optimal allocation given a sufficiently large policy schedule, but to provide a framework to study standards taking as given current market access.[10] Our paper then justifies incorporating standards into deep trade agreements based on misallocation of production across firms within a sector.

The idea that economic integration affects the level of misallocation is a focus of Edmond et al. (2015), Dhingra and Morrow (2019), and Arkolakis et al. (2019). In our setting, the optimal level of regulation interacts with the level of openness and is derived given current trade with the rest of the world. In fact, we find that lower trade costs imply a smaller optimal restrictiveness of regulation. Still, trade alone is not sufficient to eliminate allocative inefficiencies and regulations are still welfare enhancing in a fully integrated world.[11]

As argued by Costinot et al. (2020), the literature on how firm heterogeneity impacts trade policy is scant. Demidova and Rodriguez-Clare (2009), Felbermayr et al. (2013), Demidova (2017), Bagwell and Lee (2020), and Costinot et al. (2020) each explore the role of optimal import taxes and subsidies in settings with imperfect competition and firm heterogeneity. Except for Demidova (2017) and Bagwell and Lee (2020), these studies assume that markups are constant, and in general do not focus on the way that variable markups distort the allocation of resources. Our paper adds to this literature in that it provides another potentially important mechanism through which firm heterogeneity may affect the design of optimal trade policy.

Our theoretical framework is based on Macedoni and Weinberger (2022), in which the effects of regulations are examined in a closed economy framework. This paper augments their model along two dimensions. First, we consider a multi-country world, which allows us to uncover new channels, outlined above, for the welfare effects of regulations on non-imposing countries. Second, we augment the set of policies available to countries by introducing tariffs. Thus, we are able to theoretically and quantitatively compare the effects of optimal regulations and optimal tariffs. The scope and contributions of this paper are markedly different.

[10] There are two ways our model differs from Lashkaripour and Lugovskyy (2021), which builds on Bagwell and Staiger (2001). Due to the positive externality on entry, the unilateral efficient policy is *not* sufficient to restore global efficiency even when an agreement exists on market access. Second, although firm-specific subsidies or taxes can in principle solve the misallocation across entrants (while requiring full knowledge of firm's markups or quality), they alter the relationship between firm-level revenues and profits. This modifies the mass of firms that pays the fixed cost of entry, and thus does not attain the first-best allocation. Subsidies attain the first-best allocation in Lashkaripour and Lugovskyy (2021) because of the assumptions of homogeneous firms and constant markups driven by CES preferences.

[11] Khandelwal et al. (2013) provide a mechanism through which the elimination of quotas in China allows new entry of *productive* firms, and hence entry raises allocative efficiency. Our study on quality standards by construction investigates regulations where the marginal firms are of *lowest* quality and the regulation fosters new entry of high-quality firms.

Whereas our previous work is the first to establish the countervailing welfare effects of standards on the domestic economy in a flexible framework with variable markups, this paper examines the corresponding incentives for international cooperation of these domestic policies. The new gravity formulation estimates the global welfare response to a counterfactual change in regulations in either a single or all countries.

2 Stylized Facts on International Regulations

Regulations and Country Characteristics. We conduct a comparative analysis of current standards, in order to model those in a way that generates predictions consistent with the data. We use the NTM-MAP database provided by CEPII which measures the incidence of non-tariff measures across destination countries. We interpret standards as the application of *technical measures* (TMs), either sanitary and phytosanitary standards (SPS) or technical barriers to trade (TBT). These types of regulations fit most closely with the regulations in the theory because they restrict the level of quality that can survive in a market. Our prevalence measure counts only these reported barriers as a measure of TM. The data is cross-sectional and is provided for 71 countries, however we group the EU28 into one observation as all EU countries must harmonize their regulations. For further detail see Gourdon (2014).[12] The sample is made up of mostly middle-income and lower-income countries, with EU as the exception. The NTM data is merged with macroeconomic measures from the Penn World Table (PWT) 9.0 for the year 2012.[13]

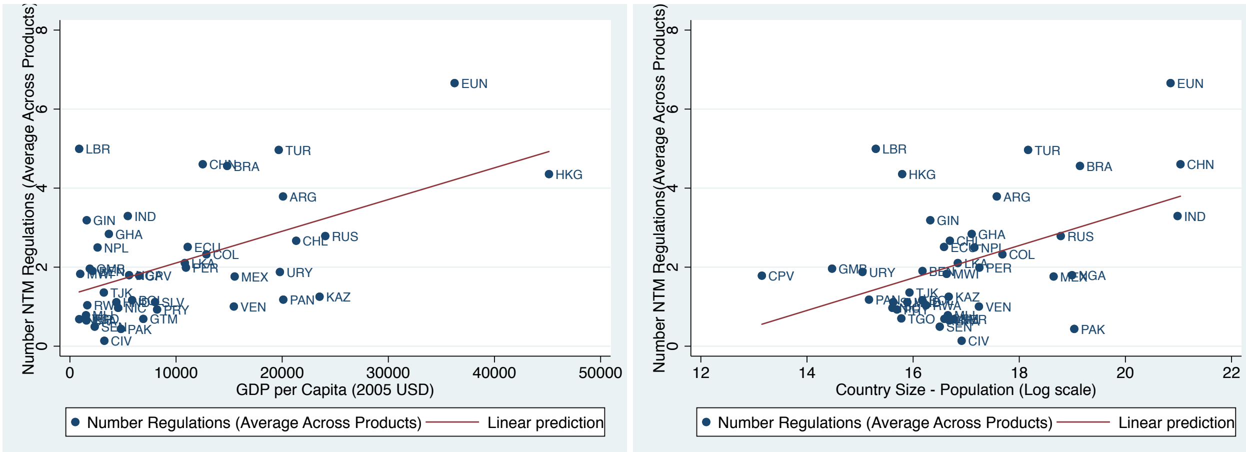
Figure 1 displays scatter plots of the TM prevalence measure, with country income and size, for 43 countries. Richer countries tend to impose more standards (left panel). The correlation between GDP per capita and the prevalence of measures is 0.54. In unreported results, we find that the correlation is (unsurprisingly) very strong with other indicators of standard of living, such as human capital, capital intensity, and TFP. In the relationship with country size, measured as population, we also observe almost the same relationship, with a correlation coefficient of 0.52.[14]. The relationship is very similar with GDP, or if we restrict standards to include only SPS, which are more likely to reflect vertical norms.

[12] We provide a data appendix in 6.1. The NTM data is provided at the country-HS2 product level on the CEPII website: `http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=28`. The prevalence measure we use captures the average number of TMs which apply to a HS6 product. We take a weighted average of the HS2 products, weighting by the number of product lines in each sector. Using the coverage ratio instead of the prevalence measure yields similar results.

[13] "EUN" represents the EU in the figures below. We aggregate its macro data as one large country.

[14] The figure uses a log scale for population in order to reduce the differences between EUN/China/India and the rest of the countries.

Figure 1: Regulations and Country Characteristics



The figure is a scatter plot of GDP per capita (left) and population (right) against the prevalence of NTM (SPS+TBT) regulations. The NTM data is provided at the country-HS2 product level by CEPII. The prevalence measure we use captures the average number of standards which apply to a HS6 product. We take a weighted average of the HS2 products, weighting by the number of product lines in each sector. Source of the national production and population data is the Penn World Table 9.0. GDP is output-side real GDP, using PPP chain-weighted prices. "EUN" is an aggregate of all EU28 countries. For the country size plot, we plot on a log scale of population due to the huge differences between EU, China, and India with the rest of the countries.

Regulations and Trade. We also provide an analysis that motivates the model in Section 3, and aims to complement the existing literature on domestic regulations and market access (Fontagné et al., 2015; Fernandes et al., 2019; Ferro et al., 2015; Cali et al., 2022). This literature has relied on export flows to argue that exporters from a specific origin (e.g France) are less likely to sell to destinations that impose relatively more regulations.[15] Fontagné et al. (2015) show that this effect is especially strong for small exporters using firm-level data for France. A rationalization of this result is that regulations impose a fixed cost on firms that restricts mainly the extensive margin of exporting. Our theoretical framework leverages this mechanism to generate reallocation from low- to high-quality firms.

In the following, we bring in the Exporter Dynamics Database (EDD) (Fernandes et al., 2016) to reproduce the fact that product regulations act on the extensive margin of trade, and extend it to study the differential effect of TMs across different types of destinations. The EDD is a dataset from the World Bank that draws on the universe of exporter transactions obtained directly from customs agencies. We use the HS2 level data, which reports the number of exporters from an origin country to many destinations at this product classification.[16] We merge this with bilateral time-invariant gravity measures from CEPII (Fouquin

[15]These regulations typically include SPS and TBT. Fontagné et al. (2015) focus only on "specific trade concerns" as these are most likely to impede trade. Our dataset includes any SPS or TBT regulation "in the books" as classified by the World Bank. This is because we attempt to capture all the domestic regulations present, or the "restrictiveness" of a market, which applies to all firms selling at that destination.

[16]There are 45 origins in the EDD data and 70 destinations. We can match the vast majority of destinations to our NTM data, but if we wanted a measure of the barriers imposed by the origin we would only be able to

and Hugot, 2016) and the NTM-MAP plus PWT data described above. We then run several specifications to study the effect that destination-specific regulations have on the number of exporters and exports per exporter. These outcomes provide information on the real *restrictiveness* of regulations, improving upon simple counts of reported standards. The most basic specification is the following:

$$\#Exporters_{ijs} = \alpha_{is} + \alpha_j + TM_{js} + Gravity_{ij} + Access_{ijs} + \epsilon_{ijs}, \tag{1}$$

where i represents origins, j destinations, and s 2-digit HS sectors. We are interested in the market access, i.e., the number of exporters, of an origin-sector group with respect to variation in sector-destination regulations. Therefore, we include a set of origin-sector and destination fixed effects, along with gravity controls ubiquitous in the trade literature ($Gravity_{ij}$). As an alternative, the specification is also reported with an additional α_{ij} – importer-exporter interacted fixed effects. Given that we exploit cross-sectional variation in technical measures, we control for destination-sector market access measures such as tariffs as well as "other" non-tariff measures in the $Access_{ijs}$ term.[17] These "other" non-tariff measures are those *not* SPS or TBT in the MAST classification, for example shipment inspections, quantity and price controls, etc. These do not necessarily discriminate based on vertically differentiated attributes, and therefore do not map to the fixed cost in our model. Importantly, we find a small and correlation (equal to -0.06) between our *TM* prevalence measure that includes only SPS and TBT with the prevalence of these "other" measures in the data. This suggests we are not confounding what we interpret as fixed costs with measures that might represent a significant amount of marginal costs.

The first column of Table 1 reports the effect of the TM prevalence measure on the number of exporters and follows exactly the specification in (1). It is clear that an origin-sector group will send fewer exporters to destinations that are more regulated, as was found in Fontagné et al. (2015). Doubling the prevalence of regulations is associated with a 3.5 percent decrease in the number of exporters.[18] The coefficients on the gravity measures confirm what is widely known – that trade barriers such as distance, no common language, and no common border will restrict the number of exporters. In the second column, we replace the gravity controls with the fullest set of fixed effects possible. In this case, we

do this for less than half the countries. In this case, we split the EU into separate countries to take advantage of variation in trade flows to separate European destinations.

[17] Tariffs are by HS2, downloaded from WITS, and non-tariff measures come from the NTM-MAP database, where we exclude SPS and TBT. We also include a product import share in one specification – the share of destination-sector imports from each origin, with the caveat that it is also determined by possible trade restrictions.

[18] As reference, doubling the prevalence of regulations might, for example, take an $i-j-s$ observation from the 25th percentile to the median in terms of prevalence scores.

confirm that regulations restrict the number of exporters in a destination.[19]

In the next three columns, we interact TMs with a destination (j) specific characteristic and include the full set of fixed effects. Countries are grouped into three bins for income (GDP per worker), size (population), and openness (the mean of exports and imports as a share of real GDP). The effects of TMs on the extensive margin of exporters is stronger when the destination has a higher GDP per capita, and when the destination is a larger economy. Figure 1 suggests that these destinations tend to impose more regulations, but the literature has struggled with the fact that quantifying regulations this way is imperfect as not all standards are necessarily equal (nor applied equally). Columns (3) and (4) confirm that these destinations are also *more restrictive*; a regulation set by a rich/large country is more successful in restricting market access. Finally, column (5) reports that technical standards are *less restrictive* in more open destinations, where openness is the average of import and export shares of GDP. Although we acknowledge the potential problems with using export information on the right hand side, note that this result is consistent with our models' prediction that trade costs and standards both reduce the optimal level of restrictiveness.

Next, we also investigate the effect of regulations on the value of exports per exporter (columns (7) and (8)).[20] Notice the difference between trade costs such as distance and regulations: they are not equivalent barriers. The effect of TMs on export values is not statistically different than zero, consistent with our interpretation that these only act on the *extensive* margin. With fewer exporters, the remaining exporters do not export less to each destination as would be the case if these acted as a marginal cost. Our results *are* consistent with TMs acting as a fixed cost that restricts the survival of low-quality firms.[21] The gravity terms, most likely reflecting marginal costs, can be interpreted as lowering average exports as costs (e.g distance) increase.[22]

[19] From now on the product import share is dropped as it is likely correlated with the prevalence of TMs.

[20] Notice that in column (6) we replicate the second column with a reduced sample size as in the specifications with export value as the outcome, to check that the differences are not due to fewer observations available for the mean export value.

[21] We acknowledge that these results identify an extensive margin response but do not guarantee that low-quality firms drive exit, as assumed in our model. Furthermore, political economy considerations come into play as big firms might lobby for regulations deterring entry by not-necessarily low-quality firms (Herghelegiu (2017)). However, the EDD is not suitable to measure firm-level quality. In our previous work we do establish that input quality proxies are strongly correlated with size in Chilean manufacturing data (as is found in Hallak and Sivadasan (2013) and consistent with Hottman et al. (2016)) and that the smallest firms were the likeliest to exit. If firm size is linked to productivity (e.g. Melitz (2003)), this also implies that exit is driven by least productive firms. Finally, this result is robust to dropping the most concentrated industries where lobbying is most likely to play a role.

[22] The negative effect of distance on average exports is consistent with previous empirical findings (Lawless, 2010), but not necessarily the modeling framework. In general, the prediction depends on the distributional assumptions. In the Melitz-Chaney framework of CES preferences and Pareto distributed firms, this coefficient is zero as the intensive margin and extensive margins cancel out. Head and Mayer (2014) argue that

Table 1: Trade Margins and Regulations

	Log # of Exporters						Log Value per Exporter	
	(1)	(2)	(Income)	(Pop'l Size)	(Openness)	(6)	(7)	(8)
TM Prevalence (log)	-0.035**	-0.028**	0.018	0.099***	-0.080***	-0.033***	-0.016	-0.011
	(0.015)	(0.012)	(0.022)	(0.026)	(0.018)	(0.012)	(0.031)	(0.033)
TM*Country Char.			-0.025***	-0.050***	0.023**			
			(0.010)	(0.009)	(0.009)			
Distance	-0.847***							-0.762***
	(0.007)							(0.017)
Common Lang	0.772***							0.259***
	(0.019)							(0.038)
Border	0.310***							0.329***
	(0.020)							(0.038)
Fixed Effects	j,i-hs2	i-j,i-hs2	i-j,i-hs2	i-j,i-hs2	i-j,i-hs2	i-j,i-hs2	i-j,i-hs2	j,i-hs2
Controls	All	Access	Access	Access	Access	Access	Access	Access
R^2	0.79	0.87	0.87	0.87	0.86	0.87	0.61	0.57
# Observations	35644	35644	35225	35225	35225	28602	28602	28602

In this table we study the effect that destination-specific regulations have on the number of exporters and exports per exporter. The outcome in columns (1)-(6) is the number of exporters from i that sell in js. In column (1) we control for the product import share plus access restrictions (tariffs and other non-tariff measures), and destination plus origin-sector fixed effects. In column (2) we include origin-destination and origin-sector fixed effects, as well as access controls. Since the import share control doesn't have a large effect and is plausibly correlated to regulations, we drop it from the rest of the specifications. In columns (3)-(5) we group countries into three bins, akin to "low", "middle" and "high" income/size/openness, and interact the country bin with the TM prevalence measure. Column (6) has the same sample size as the export value specifications for comparison. In columns (7) and (8) we use the mean log export value per exporter (as reported by EDD) as the outcome. In column (8) we return to only destination and origin-sector fixed effects with gravity controls. To construct the prevalence measure of regulations, we allow for SPS and TBT chapters only within NTM-MAP data. Regulations are for a destination-sector (js). For the interaction terms in columns (3)-(5), GDP/L is the log of real GDP (in millions of 2005 USD) over millions of engaged persons (employed), Population is the log of the population size of the country, and Openness is the average of import and export shares of GDP, as calculated by PWT. As in Fernandes et al. (2018), we restrict origin-destination pairs to those with sufficient transactions (at least 200 exporters from i in j). $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Robustness We conduct a robustness analysis with results in Appendix 6.2. A concern with the specification above is that the choice to implement regulations is itself correlated with export behavior. It could also be that fixed costs, which we argue increase with regulations, are correlated with variable costs (though, in column (2), we control for all importer-exporter determinants). Although it is difficult to find valid instruments for country-specific regulations, we follow the strategy in Kee and Nicita (2016) and Shmidt and Steingress (2018), and use TMs of related countries. For each destination, we take the average number of regulations imposed in the same sectors by countries that either share a border, a common language, or a common legal origin. These reflect similar institutions that can be correlated with distance, but since variance costs might be correlated with fixed costs, they also include partners that are not necessarily close to each other.

Table 3 replicates columns (6) and (7) of the previous table with the regulations instrumented as described above. We include the instruments separately and in an over-identified specification. We do confirm that the number of exporters is lower when there are more

it is negative with a log-normal distribution of firms as the intensive margin increases. We do not delve into this effect as we assume a Pareto distribution of firms and focus on the effects of regulations.

TMs imposed, and the coefficient increases relative to the OLS specification. Furthermore, we find that an endogeneity test *cannot* reject the null that the number of regulations is exogenous, which gives credence to the analysis outlined above.

3 Model

We build a multi-country model of international trade to study the optimal level of regulations in the context of market power heterogeneity. There are I countries indexed by i for origins and j for destinations. In each country i, L_i consumers, with per capita income y_i, enjoy the consumption of varieties of a differentiated good. The varieties are produced by a mass of single-product firms, which differ in terms of their quality z. We assume that quality z is a demand shifter: consumers exhibit a higher willingness to pay for higher quality goods. There is perfect information: consumers, firms, and the government costlessly distinguish between the quality offered in the market.

As in the Melitz (2003) model, there is a pool of potential entrants. Upon entry, firms pay a fixed cost of entry f_E in domestic labor units and discover their quality z. Quality is drawn from an unbounded Pareto distribution whose CDF and pdf are $H_i(z) = 1 - \left(\frac{b_i}{z}\right)^\kappa$ and $h_i(z) = \frac{\kappa b_i^\kappa}{z^{\kappa+1}}$, where κ and b_i are positive constants. Only a mass J_i of firms pays the fixed cost of entry. Free entry drives expected profits equal to $w_i f_E$. The market is monopolistically competitive.[23] All firms from i produce their goods with the same marginal cost of production c_i, in labor units. These assumptions imply that size heterogeneity is linked to the exogenous quality draws. The direct mapping of quality to size might seem stark, but it is a convenient feature that is also present in Kugler and Verhoogen (2012) and finds quantitative support in the empirical findings of Hottman et al. (2016).

There is an iceberg trade cost of delivering a good $\tau_{ij} \geq 1$ with $\tau_{ii} = 1$. Furthermore, each exporter pays a per unit tariff $t_{ij} \geq 1$ with $t_{ii} = 1$. Following the notation of Demidova (2017), let $p_{ij}(\omega)$ denote the price of a variety ω that is inclusive of tariff. Net of the tariff, the firm receives $\frac{p_{ij}(\omega)}{t_{ij}}$ and the government collects $(t_{ij} - 1)\frac{p_{ij}(\omega)}{t_{ij}}$. Workers earn a wage w_i. Per capita income y_i is the sum of the wage and the tariff revenue, which is distributed equally across consumers, i.e. $y_i = w_i + \frac{T_i}{L_i}$, where T_i denotes total tariff revenues.

Regulations will be introduced below as a requirement that all firms selling to j pay a fixed cost in labor units. While this modeling approach is motivated by the evidence that domestic standards act on the extensive margin, suggesting that regulations have an

[23] In general, misallocations can arise because of inefficient mass of firms that pay the fixed cost of entry or because of inefficient allocation of production among entrants. Under Pareto and monopolistic competition, the mass of firms that pay the fixed cost of entry is efficient. Hence, we are able to focus on the misallocation of production among firms that pay the fixed cost of entry.

important reallocation effect, we recognize that regulations are often imposed to address consumption externalities. Although we do not model explicitly these possible foundations for regulations, an extension to the baseline model in Appendix 6.5 includes an explicit externality associated with the consumption of goods of higher quality, showing that the main results we discuss below hold. Our choice to leave the ad hoc externality as an extension is for the following reason. Regulations cover a wide range of norms imposed to address different types of externalities (e.g. environmental externalities, or asymmetric information), with a common implication across these regulations being that the smallest firms drop out. It is difficult to quantify such diverse group of externalities with one functional form, and for that reason we prefer to allow a policymaker a flexible fixed cost with the goal, for example, to have a certain level of average quality in the market. The present framework allows us to capture the novel reallocation and entry effects that are not present in previous papers on product standards.

3.1 Consumer and Firm Problems

We adopt a special case of the Generalized Translated Power (GTP) preferences proposed by Bertoletti and Etro (2020), modified slightly to include a variety specific demand shifter that accounts for quality. Importantly, this general system of preferences implies firms face demand elasticities that are a function of firm size, and thus does not restrict markups across firms to be constant as in the commonly used CES case. In Macedoni and Weinberger (2022), we find that market distortions in this framework are driven entirely by the presence of variable markups and show in a closed economy framework that regulations improve welfare for an array of parametric specifications. For brevity, we relegate the description of preferences to Appendix 6.3. In this paper, we fix parameters to obtain Indirectly Additive (IA) preferences as described by Bertoletti et al. (2018).[24] We state here only the consumers' inverse demand function:

$$p_{ij}(\omega) = y_j \left[az(\omega) - (\xi_j q_{ij}(\omega))^{\frac{1}{\gamma}} \right] \tag{2}$$

where $a > 0$ and $\gamma \geq 0$ are constants, ξ_j is an implicitly defined quantity aggregator, $q(\omega)$ is the quantity consumed of variety ω, $z(\omega)$ is a variety specific demand shifter, which we interpret as quality, and $p_{ij}(\omega)$ is the price of variety ω.

As we model government regulations as a fixed cost, which affects the production-exit decisions of firms, we can solve the problem of monopolistically competitive firms conditional

[24]This choice guarantees that our model remains highly tractable while maintaining enough flexibility to match the data well. We refer the reader to our earlier work for the quantitative differences across preferences.

on being active, and later examine the effects of regulations. The constant returns to scale assumption allows us to study the problem of a firm operating in each destination j independently. Given the quality draw z, a firm from i maximizes its profits in a destination j by choosing the quantity $q_{ij}(z)$ and taking ξ_j as given. As each firm produces one variety, we now label a variety with index z. We leave the derivations for the firm's problem and the optimal supply of a variety with quality z to Appendix 6.3. Here, we show the market determined quality cutoff which controls the selection of firms from i in market j:

$$z_{ij}^* = \frac{t_{ij}\tau_{ij}w_i c_i}{a y_j} \tag{3}$$

For a quality level below the cutoff $z < z_{ij}^*$, a firm has zero demand. Absent any fixed costs of operation, z_{ij}^* would be the only source of selection of firms into production, export, or exit. An important property of IA preferences is that the market quality cutoff is only a function of the origin marginal costs of production, and of the destination per capita income. In particular, richer destinations have a lower quality cutoff. The optimal pricing rule is a function of the cutoff:

$$p_{ij}(z) = \frac{a y_j z_{ij}^*}{1+\gamma}\left(\frac{z}{z_{ij}^*} + \gamma\right) \tag{4}$$

Prices are increasing in per capita income of the destination, but are unresponsive to market size, in line with the evidence as discussed in Macedoni and Weinberger (2022). In that paper, we also establish that our model is isomorphic to one with productivity heterogeneity where marginal costs increase with quality, linking our results to empirical papers that have established the positive link between quality and prices/markups.

3.2 Fixed Regulatory Costs

The government of each country can set a regulation that requires all firms selling to j the payment of a fixed cost in labor units. We denote such a fixed cost as f_{ij}, which includes wages. We will explore both the case in which the fixed cost is paid in the domestic labor units of a firm, and the case in which the fixed cost is paid in the destination labor units. The former case captures compliance tasks that are completed by the firms workers, e.g. quality controls, environmental requirements etc. The latter case captures the compliance tasks that require hiring destination country's workers, e.g. flying out inspectors.

The presence of a fixed cost forces some low-quality firms to exit relative to the market allocation. In fact, firm profits equal $\pi_{ij}(z) = \tilde{\pi}_{ij}(z) - f_{ij}$. As profits are increasing in quality z, there exists a firm with quality $\bar{z}_{ij}$ such that $\pi_{ij}(\bar{z}_{ij}) = f_{ij}$. Any firm with $z < \bar{z}_{ij}$ exits. $\bar{z}_{ij}$ is defined by as:

$$\bar{z}_{ij} = z^*_{ij} + z^*_{ij}\left[f_{ij}\left(\frac{(1+\gamma)^{1+\gamma}}{a^{1+\gamma}\gamma^\gamma}\right)\left(\frac{\xi_j t_{ij}}{L_j y_j (z^*_{ij})^{1+\gamma}}\right)\right]^{\frac{1}{1+\gamma}}$$

Consider $g_{ij} = \frac{\bar{z}_{ij}}{z^*_{ij}} \in [1, \infty)$ as a measure of the restrictiveness of the regulation. Absent any fixed costs, $g_{ij} = 1$. For larger levels of the fixed cost, our measure of restrictiveness increases, and even with non-discriminatory fixed costs, the restrictiveness is not equal across origins. The measure g_{ij} is related to the probability of a firm being active under the regulation, relative to the probability of being active without the regulation: $\frac{P(z \geq \bar{z}|g>1)}{P(z \geq \bar{z}|g=1)} = g^{-\kappa}$. Thus, g_{ij} captures a scale-free measure of the restrictiveness of the regulation. For each origin country i, g_{ij} is implicitly defined by:

$$\left(\frac{a^{1+\gamma}\gamma^\gamma}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j y_j (z^*_{ij})^{1+\gamma}}{\xi_j t_{ij}}\right)(g_{ij}-1)^{1+\gamma} = f_{ij} \tag{5}$$

Since g_{ij} is also a function of z^*_{ij}, (5) does not pin down the restrictiveness of the standard. However, solving the model shows that there is a one-to-one mapping between f_{ij} and g_{ij}, meaning that for any level of fixed cost there is only one level of restrictiveness of the regulation (see Appendix 6.4.1). To find a simple equation that describes the relationship between the restrictiveness of the standard for domestic firms g_{jj} and for foreign firms g_{ij}, we first take the ratio of (5) for origin j and for origin i. Then, we substitute for the market quality cutoff ratio using $\frac{z^*_{ij}}{z^*_{jj}} = \frac{t_{ij}\tau_{ij}w_i c_i}{w_j c_j}$ by (3). This yields:

$$g_{ij} = 1 + (g_{jj}-1)\frac{w_j c_j}{\tau_{ij} w_i c_i}\left(\frac{f_{ij}}{f_{jj}}\right)^{\frac{1}{1+\gamma}} t_{ij}^{-\frac{\gamma}{1+\gamma}} \tag{6}$$

The level of restrictiveness of the same regulation generally differs between domestic and foreign firms as the same regulation has a more lenient effect on source countries with higher average quality. In fact, larger costs of production and delivery impose a stronger selection of high-quality firms that are able to access the domestic economy, thus, reducing the perceived restrictiveness of regulations for foreign firms. Notice that the exponent on t_{ij} is different from τ_{ij} because firm profits are net of tariffs. Depending on whether the fixed cost of compliance is expressed in home labor units or domestic labor units, we obtain:

$$g_{ij} = 1 + (g_{jj}-1)\frac{w_j c_j}{\tau_{ij} w_i c_i} t_{ij}^{-\frac{\gamma}{1+\gamma}} \qquad \text{if } f_{ij} = w_j f_j \tag{7}$$

$$g_{ij} = 1 + (g_{jj}-1)\frac{w_j c_j}{\tau_{ij} w_i c_i}\left(\frac{w_i}{w_j}\right)^{\frac{1}{1+\gamma}} t_{ij}^{-\frac{\gamma}{1+\gamma}} \qquad \text{if } f_{ij} = w_i f_j \tag{8}$$

We choose to model the costs associated with the regulations as a fixed cost because their effects are consistent with our stylized facts and literature cited above. Fixed costs of regulation generate selection of firms based on their quality, thus, they mainly affect the extensive margin of exports. Furthermore, the fixed costs generates a reallocation of production from low-quality firms that exit to high-quality firms. We note that any increases in the marginal costs of production due to the regulation is unambiguously welfare reducing.

3.3 Aggregation and Equilibrium

Although governments set the fixed cost of regulation, we can make the simplifying assumption that what is *chosen* is actually the level of restrictiveness of the regulation in the domestic economy g_{jj}. In fact, given the other parameters of the model, there exists a level of the fixed costs that maps into a given value of g_{jj}. Then, g_{ij} follows from the relationships above and it is not necessary to know the (implied) fixed cost. This assumption is particularly important for section 4, since we are able to estimate g_{ij} and g_{jj} without having to estimate the fixed costs, which are notoriously difficult to estimate.

Access to a destination j is dampened by the regulation. In fact, the mass of active firms N_{ij} from i selling to destination j equals:

$$N_{ij} = \frac{J_i b_i^{\kappa}}{\bar{z}_{ij}^{\kappa}} = \frac{J_i b_i^{\kappa}}{(z_{ij}^{*} g_{ij})^{\kappa}} = a^{\kappa} J_i b_i^{\kappa} (c_i w_i)^{-\kappa} w_j^{\kappa} (t_{ij} \tau_{ij} g_{ij})^{-\kappa} \tag{9}$$

This prediction is consistent with our stylized fact where we document a negative relationship between number of exporters and restrictiveness of regulations, controlling for origin and destination fixed effects, as well as for trade costs τ_{ij}. The origin fixed effect captures the aggregate mass of firms active in the origin, weighted by the costs of production: $J_i b_i^{\kappa}(c_i w_i)^{-\kappa}$. The destination fixed effect captures the income of the destination, which increases the extensive margin.

We leave the derivations of the aggregate variables to the Aappendix. Aggregate revenues (net of tariffs) of firms from i to j are given by:

$$R_{ij} = N_{ij} \int_{\bar{z}_{ij}}^{\infty} r_{ij}(z) \frac{\kappa \bar{z}_{ij}^{\kappa}}{z^{\kappa+1}} dz = \left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}} \right) \left(\frac{L_j y_j (z_{jj}^{*})^{-\kappa+1+\gamma}}{\xi_j (c_j w_j)^{-\kappa+1+\gamma}} \right) (\tau_{ij} c_i w_i)^{-\kappa+\gamma+1} t_{ij}^{-\kappa+\gamma} J_i b_i^{\kappa} g_{ij}^{-\kappa} G_2(g_{ij})$$

where $G_2(g_{ih}) = \kappa g_{ih}^{\gamma} \left[\frac{g_{ih}\, {}_2F_1[\kappa-\gamma-1, -\gamma; \kappa-\gamma, g_{ih}^{-1}]}{\kappa-\gamma-1} + \frac{\gamma\, {}_2F_1[\kappa-\gamma, -\gamma; \kappa-\gamma+1, g_{ih}^{-1}]}{\kappa-\gamma} \right]$, and ${}_2F_1[a, b; c, d]$ is the hypergeometric function. We can derive the gravity equation, by considering the share of sales of products from i to country j including tariffs:

$$\lambda_{ij} = \frac{t_{ij}R_{ij}}{\sum_v t_{vj}R_{vj}} = \frac{(t_{ij}\tau_{ij}c_i w_i)^{-\kappa+\gamma+1} J_i b_i^\kappa g_{ij}^{-\kappa} G_2(g_{ij})}{\sum_v (t_{ij}\tau_{vj}c_v w_v)^{-\kappa+\gamma+1} J_v b_v^\kappa g_{vj}^{-\kappa} G_2(g_{vj})} \tag{10}$$

Thus, bilateral trade flows are dampened by variable trade costs (with elasticity $\kappa - \gamma - 1$), and by the restrictiveness of the regulation.

Market clearing implies that

$$\sum_j \lambda_{ij} y_j L_j = y_i L_i \quad \forall i = 1, ..., I \tag{11}$$

By the expected zero profit condition, $E[\pi_i] = w_i f_E$, we obtain the equilibrium mass of entrants in country i:

$$J_i = \frac{1}{w_i f_E} \sum_j \frac{\lambda_{ij}}{t_{ij}} y_j L_j \frac{\tilde{G}_1(g_{ij})}{\tilde{G}_2(g_{ij})} \quad \forall i = 1, ..., I \tag{12}$$

where $\tilde{G}_1(g_{ij}) = g_{ij}^{-\kappa}[G_1(g_{ij}) - (g_{ij}-1)^{1+\gamma}]$, $G_1(g_{ih}) = \kappa g_{ih}^\gamma \left[\frac{g_{ih}\,{}_2F_1[\kappa-\gamma-1,-\gamma;\kappa-\gamma,g_{ih}^{-1}]}{\kappa-\gamma-1} - \frac{{}_2F_1[\kappa-\gamma,-\gamma;\kappa-\gamma+1,g_{ih}^{-1}]}{\kappa-\gamma}\right]$, and $\tilde{G}_2 = g_{ij}^{-\kappa} G_2(g_{ij})$. Contrary to standard monopolistic competition model with a Pareto distribution of the underlying firm characteristics, the mass of entrants is no longer constant, as it depends on the level of regulations and on the equilibrium wage.

Finally, the relationship between wages and per capita income is given by:

$$y_j = w_j + y_j \sum_i \left(\frac{t_{ij}-1}{t_{ij}}\right) \lambda_{ij} \quad \forall j = 1, ..., I \tag{13}$$

Without loss of generality, we can normalize the wage of a country k to one and set it as the numeraire. The equilibrium in the model is a vector of wages $\{w_i\}$ for $i \neq k$, per capita income $\{y_i\}$ for $i = 1, ..., I$, and mass of entrants $\{J_i\}$ for $i = 1, ..., I$, such that goods markets clear, trade is balanced, and expected profits equal the fixed cost of entry.

The utility of the representative consumer is given by:

$$\tilde{U}_j = U_j - 1 = a^\kappa \left(\frac{\gamma}{1+\gamma}\right)^{1+\gamma} \frac{J_j b_j^\kappa \left(\tau_{jj} c_j w_j y_j^{-1}\right)^{-\kappa+\gamma+1}}{\lambda_{jj}} \tilde{G}_2(g_{jj}) \sum_i \frac{\lambda_{ij} G_1(g_{ij})}{G_2(g_{ij})} \tag{14}$$

3.3.1 General Effects of Regulation Changes

By use of the hat algebra as in Arkolakis et al. (2012), we can easily characterize the changes in the equilibrium values of our endogenous variables, as well as welfare, following any change in the regulatory restrictiveness of countries. Though our primary focus is on regulations, our model also allow us to consider the effects of changes in tariffs t_{ij}, which allow us to examine the interaction between the two policies. Hence, the exogenous sources of shock in our model are regulations and tariffs. We abstract from endogenous policy responses so that changes in one of the two instruments do not mechanically change the other. The hat algebra technique allows us to consider these changes given a parsimonious set of parameters and a general equilibrium object. This property of the technique is particularly useful in section 4, where we use the expressions we derive in this section to quantify the welfare effects of various counterfactuals.

Any change in the level of domestic regulation g_{jj} is reflected to changes in the restrictiveness faced by firms from i when exporting to j (g_{ij}), as described in (6). Given exogenous changes in g_{ij} for $i, j = 1, ..., I$, and exogenous changes in t_{ij} $i, j = 1, ..., I$, for the initial levels of w_i, λ_{ij}, g_{ij}, and t_{ij} we can characterize the changes in trade shares, wages, and mass of entrants.

We denote with $\hat{x} = \frac{x_{new}}{x_{old}}$ the change in a variable, and apply the hat algebra to the equations (10), (11), (12), and (13). The system of equations is as follows:

$$\hat{\lambda}_{ij} = \frac{\hat{J}_i \hat{w}_i^{-\kappa+\gamma+1} \hat{t}_{ij}^{-\kappa+\gamma+1} \hat{\tilde{G}}_2(g_{ij})}{\sum_v \lambda_{vj} \hat{J}_v \hat{w}_v^{-\kappa+\gamma+1} \hat{t}_{vj}^{-\kappa+\gamma+1} \hat{\tilde{G}}_2(g_{vj})} \qquad \forall i, j = 1, ...I \tag{15}$$

$$\hat{y}_i = \frac{\sum_j \lambda_{ij} y_j L_j \hat{\lambda}_{ij} \hat{y}_j}{\sum_j \lambda_{ij} y_j L_j} \qquad \forall i = 1, ..., I \tag{16}$$

$$\hat{J}_i = \frac{1}{\hat{w}_i} \frac{\sum_j \frac{\lambda_{ij}}{t_{ij}} y_j L_j \frac{\tilde{G}_1(g_{ij})}{\tilde{G}_2(g_{ij})} \frac{\hat{\lambda}_{ij}}{\hat{t}_{ij}} \hat{y}_j \widehat{\left(\frac{\tilde{G}_1(g_{ij})}{\tilde{G}_2(g_{ij})}\right)}}{\sum_j \frac{\lambda_{ij}}{t_{ij}} y_j L_j \frac{\tilde{G}_1(g_{ij})}{\tilde{G}_2(g_{ij})}} \qquad \forall i = 1, ..., I \tag{17}$$

$$\hat{y}_j = \frac{w_j}{y_j} \hat{w}_j + \sum_i \widehat{\left(\frac{t_{ij} - 1}{t_{ij}}\right)} \hat{\lambda}_{ij} \hat{y}_j \left(\frac{t_{ij} - 1}{t_{ij}}\right) \lambda_{ij} \qquad \forall j = 1, ..., I \tag{18}$$

To compute the welfare changes due to the change in regulation we consider the equivalent variation in income which leaves consumers indifferent between the new equilibrium at the new level of regulation, and the initial allocation. First, we need to compute the change in utility following a change in regulation, using (14):

$$\hat{\tilde{U}}_j = \frac{\hat{J}_j}{\hat{\lambda}_{jj}} \left(\frac{\hat{w}_j}{\hat{y}_j}\right)^{-\kappa+\gamma+1} \hat{\tilde{G}}_2(g_{jj}) \frac{\sum_i \frac{\lambda_{ij} G_1(g_{ij})}{G_2(g_{ij})} \frac{\hat{\lambda}_{ij} \hat{G}_1(g_{ij})}{\hat{G}_2(g_{ij})}}{\sum_i \frac{\lambda_{ij} G_1(g_{ij})}{G_2(g_{ij})}} \tag{19}$$

Then, we compute the equivalent variation in income by deriving the change in utility due to a change in income, keeping the price distribution unchanged. We leave the details to the appendix and, to preserve tractability, we use the local approximation to derive the equivalent variation in income. The welfare formula is then:

$$d\ln W_j = \frac{\sum_i \lambda_{ij} \frac{G_1(g_{ij})}{G_2(g_{ij})}}{1+\gamma}(\hat{\tilde{U}} - 1) \tag{20}$$

3.4 Welfare Effects of Regulations

With the setup above it is now possible to examine the relationship between regulations and allocative inefficiency across heterogeneous firms. First, we show that regulations can improve welfare in an open economy framework. Second, we discuss the role of cooperation in setting regulations by examining the welfare change of the foreign country in response to the home country policy change. Third, we compute the optimal level of the regulation as a function of tariffs and trade costs and use our model to make predictions about the level of regulations that countries of different sizes and average quality level impose optimally. To proceed, we consider a version of the model outlined in the previous section with only two countries, home and foreign, denoted by subscript h and f.

By examining the relationship between welfare and regulation we find that the results of Macedoni and Weinberger (2022) also hold in a trade environment. There is a non-monotone hump shaped relationship between the restrictiveness of the regulation g_{hh} and the utility of home consumers, shown in Panel (a) of Figure 2. A small level of fixed costs of compliance to regulations can improve welfare. Such a result arises regardless of the origin of the labor required to comply to regulations: welfare improves both in the case in which firms use their domestic labor or the labor of the home economy.

The intuition for the result above can be conveyed as in a closed economy. Increased regulatory restrictiveness has two main effects: a composition effect, which is welfare improving as it reallocates production from low- to high-quality firms and, thus, raises average quality. The second effect is a reduction in the number of varieties available for consumption, which is welfare reducing as consumers have a love for variety.[25] For a small level of the fixed cost, the first effect dominates and welfare improves. The result hinges on misallocation of production under the market allocation: due to the markup heterogeneity, there is over-production by low-quality firms. The fixed costs reduces such misallocation by forcing out of the market low-quality firms.[26]

[25] Furthermore, there is potentially an anti-competitive effect, whereby surviving firms charge higher markups in response to the reduction in competition. This channel is absent here due to the assumption of IA preferences.

[26] In the aforementioned paper, we emphasize that the channel by which welfare increases is novel to

The exit of domestic low-quality firms and the entry of new higher-quality firms from the imposing country increases the openness of both countries, as the domestic expenditure share λ_{jj} declines in both countries. Relative to the closed economy case, in an open economy there are two additional channels. First, changes in regulation affects the mass of foreign firms.[27] Increases in g_{hh} determine a rise in the mass of home *and* foreign firms that pay the fixed cost of entry: as only higher quality firms survive, average profits in the economy are higher. Holding constant the mass of foreign firms, the welfare effects of regulations are diminished, as smaller entry is equivalent to fewer varieties available for consumption.

The second channel through which g_{hh} affects welfare in an open economy setting is the home relative wage w_h and per capita income y_h. This is a terms of trade effect of the regulation, as changes in the relative wage reflect changes in the relative purchasing power of consumers in the two countries. In particular, as the restrictiveness of the standard increases, wages and per capita income decline. As workers move from output production to the compliance activities captured by their fixed costs, their purchasing power declines. In appendix Figures 6 and 7, we show the relationships between regulations, entry, purchasing power, and trade openness.

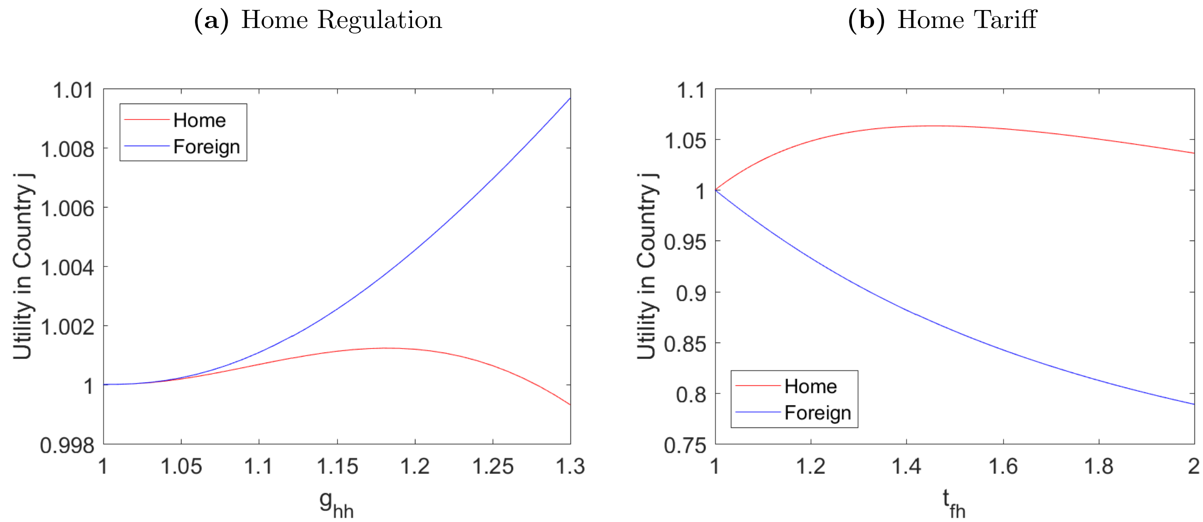
The Role of Cooperation. An important theoretical result is the positive externality of regulations in one country on the welfare of other countries. In particular, we find that when the home economy increases its level of restrictiveness of regulations, welfare in the foreign economy improves, despite the lack of change in their domestic level of the regulation. This is shown in Panel (a) of Figure 2, where the home regulation monotonically increases the foreign utility, while it exhibits a hump-shaped relationship with the home utility. This is in contrast with Panel (b), in which we plot the welfare effects at home and abroad of a higher home tariff. The tariff increases home welfare at the expenses of foreign welfare. Instead, the regulation increases home *and* foreign welfare.

The foreign economy benefits from the reallocation of production towards high-quality firms in the home economy. To see this, consider the change in utility for the foreign economy $\hat{U}_f$. We evaluate (19) for the foreign economy given a change in the home regulations, at an initial equilibrium with no regulations and no tariffs, in a model with two symmetric

the literature on quality standards and is possible *only* due to the endogenous distortion that arises in the presence of variable markups. In the often explored case where markups are constant (Gaigné and Larue, 2016a; Mei, 2021), the variety effect always dominates. The assumption of variable markups has been established empirically, e.g. Hottman et al. (2016) and Mrázová et al. (2021).

[27] The effects of home trade policies on the mass of foreign firms is typically only a property of the trade policies of large countries as small open economies are usually assumed not to have an influence on foreign entry (Demidova and Rodríguez-Clare, 2013).

Figure 2: Welfare Effects of Trade Policies



The plots show the hat change in the home utility $\hat{U}_h$ and foreign utility $\hat{U}_h$ given changes in the home regulation g_{hh} and home tariff t_{fh}. The parameters are as follows: $\kappa = 4$, $\gamma = 1.5$, $\lambda_{hh} = \lambda_{ff} = 0.65$. In the initial equilibrium the two countries are identical and size and per capita income are normalized to one. In the initial equilibrium, there are no regulations and there is a symmetric level of tariffs $t_{hf} = t_{fh} = 1.01$. The iceberg trade costs are derived using the gravity equations and the numerical values for trade shares and tariffs.

countries:

$$\hat{U_f} = \lambda \hat{J_f} + (1 - \lambda) \hat{J_h} \hat{w}_h^{-\kappa+\gamma+1}$$

where λ is the domestic expenditure share and we used (15) to substitute the changes in trade shares.

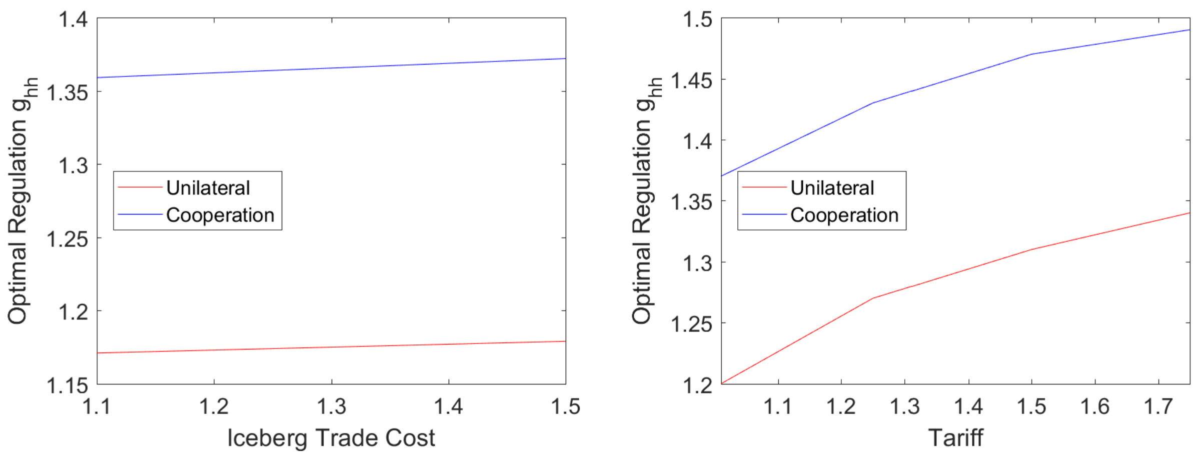
Regulations in the home country benefit the foreigners in three ways. First, home regulations increase home entry ($\hat{J_h} > 1$) and, thus, the foreign economy benefits from new varieties. Second, there is a terms of trade effect through the home wage, which decreases. A decline in the home wage is equivalent to an increase in the foreign purchasing power. Finally, there is an increase in foreign entry which benefits the foreign economy because of new varieties. These three effects more than offset the welfare costs of higher fixed costs to export to the home economy.

The result is important as it eliminates a beggar-thy-neighbor rationale for imposing the regulation. When a country imposes a standard, welfare does not improve at the expenses of foreign economies, in fact welfare in the foreign economy improves *always*. An implication of our findings is that it motivates international cooperation in imposing regulations. When countries impose a standard they do not internalize the positive externality on foreign economies, and thus the restrictiveness of the standard is below the social optimum. In fact, in Figure 3, we compare the optimal level of regulation imposed in two scenarios. In the first scenario, only the home economy imposes the standard (Unilateral). In the second scenario, a common standard is optimally chosen to maximize welfare in both economies. As shown in Figure 3, the optimal standard under cooperation is higher than the optimal standard chosen by countries unilaterally.

Figure 3: Optimal Regulation under Cooperation

(a) Varying Trade Costs

(b) Varying Tariffs



The plots show optimal regulation g_{hh} in the case of cooperation (i.e., $g_{hh} = g_{ff}$) and in the case in which the home economy is the only one to impose the standard (Unilateral). Countries are symmetric, $\kappa = 4$, and $\gamma = 1.5$. In the initial equilibrium the two countries are identical and size and per capita income are normalized to one. Trade costs and tariffs are symmetric. When varying the iceberg trade costs, tariffs are set to one; when varying the tariffs, the iceberg trade costs equal 1.5.

We have considered the Nash Equilibrium arising when both economies impose a standard. Figure 8 in the appendix plots the best response function for the home economy, which is generally flat and slightly increasing. Hence, the optimal restrictiveness of regulation of the home economy is largely independent of the regulation imposed by the foreign economy. The reason for that is that the foreign regulation does not affect the distortions in the home economy. Since the cutoff z^*_{hh} is constant, because of IA preferences and assuming no tariffs, the production of high-quality firms relative to low-quality firms is independent of the level of foreign regulation. Since the home regulation improves welfare because low-quality firms under-produce, and the foreign regulation does not affect that, the incentives to set g_{hh} are unchanged. This result supports our approach of considering the case in which only the home economy imposes the regulation, which is much faster to compute relative to the Nash equilibrium.

The results of this section justify trade agreements and, in particular, deep trade agreements because of the presence of a positive externality. The prediction is that, when countries enter a deep trade agreement, they cooperatively increase the restrictiveness of regulations.[28] Furthermore, notice that the optimal level of regulation under cooperation declines with the

[28] In the presence of asymmetric countries, the optimal level of regulation would depend both on the positive externality and on the fact that the optimal regulation across heterogeneous countries varies, as we show after.

level of iceberg trade costs and tariffs (Figure 3). This means that countries in deep trade agreements who are able to reduce their iceberg trade costs and tariffs, if these are still in place, can also reduce the restrictiveness of the regulations. Notice that even for very low trade costs, the optimal g_{jj} is above one.

We also verify whether the welfare improvements due to cooperation increase or decrease with the level of tariffs. In particular, we evaluate the percentage in the utility of consumers $\hat{U} - 1$ due to the imposition of the optimal level of regulations, relative to the case of no regulations. Figure 9 in the appendix shows that the welfare benefits of regulations are lower for higher levels of the iceberg trade costs: not only is a reduction in trade costs is associated with a lower optimal level of regulation, but also the welfare benefits of imposing a regulation increase. The result suggests that the rationale provided by the positive externality for a deep trade agreement declines with the iceberg trade costs. Nevertheless, the welfare benefits from cooperation are large at any level of iceberg trade costs, as the percentage change in utility are 3 to 6 times the change in utility due to a unilateral imposition of regulation.

Optimal Regulation, Trade Costs, and Tariffs. As seen in the previous paragraph, changes in trade costs change the optimal level of regulations that countries impose. To illustrate the relationship between regulations and trade costs, we conduct a numerical exercise where we compute the welfare maximizing level of the restrictiveness of regulations g_{hh} as a function of iceberg trade costs τ_{ij} and tariffs t_{ij}. Notice that the results are not qualitatively affected by which units of labor the fixed costs are expressed in.[29]

Figure 10 in the appendix shows the positive relationship between optimal restrictiveness of standards, iceberg trade costs, and tariffs associated with exporting from and to the home economy. When foreign export costs or domestic export costs decline, the optimal standard falls. A reduction in τ_{fh} or t_{fh} reallocates consumption, hence production, from low-quality domestic varieties to (relatively) high-quality foreign varieties. Similarly, a reduction in τ_{hf} and t_{hf} reallocates production from low-quality non-exporter to high-quality exporters. In both cases, the reallocation generated by trade costs reduce the same distortion that allow regulations to be welfare-improving.

For a similar reason, there is a positive relationship between restrictiveness of regulations and optimal tariff (see Figure 12 in the appendix). Reductions in the level of the regulation reallocate production towards low-quality firms and lower import tariffs partially offset such a reallocation.

[29] In the figures, Dest FC labels the case in which the fixed cost of compliance is expressed in labor units of the destination, and Source FC in labor units of the source country.

Optimal Regulation, Size, and Technology. We use our model to compute the optimal level of g_{hh} as a function of domestic relative size L_h and domestic relative unit costs c_h. Our first result is that larger economies have larger values of optimal g_{hh} (Figure 11 in the appendix). To understand this, consider two economies identical in every aspect but size: one economy is twice the size of the other. Imposing a regulation in each country has similar qualitative effects. However, the quantitative effects are different. The larger economy experiences a slower reduction in the wage, as workers move towards compliance activities. Furthermore, the larger economy experiences a faster growth in the mass of entrants. As a result, welfare in the large economy increases more with the standard.

A similar effect occurs when considering economies that are more technologically efficient and, thus, have higher per capita income. As the home economy unit costs c_h declines, the optimal level of regulation rises. This theoretical results finds support in our empirical analysis, where we document a positive relationship between restrictiveness of TMs (in the way they affect the extensive margin) and size and per capita income of a country. Our model predicts that larger and richer economies optimally impose more restrictive regulations.

4 Quantitative Analysis

The goal of this section is to leverage the gravity formulation of the model in order to estimate parameters and provide a counterfactual exercise which results in the (world) welfare consequences of either one or several countries concurrently changing their regulation policy. As shown in Section 3.3, the gravity framework outlined in the previous section allows for a counterfactual exercise that computes the general equilibrium welfare consequences of policy changes. Given the changes in g_{jj} for $j = 1, ..., I$ and in t_{ij} for $i, j = 1, ..., I$, as well as the initial levels of w_i, y_i, λ_{ij}, t_{ij}, and g_{ij}, we can characterize the changes in trade shares, wages, per capita income, and mass of entrants through equations (6), (15)-(18).

4.1 Estimation of the Model

This section describes the algorithm we use to estimate the main parameters required for the counterfactual analysis. First, we describe the data sources and procedures required for wages, trade shares, tariffs, and country size, as well as how we estimate the parameters κ and γ. Second, we outline the algorithm that estimates country-pair restrictiveness regulations g_{ij}, for a sample of trading partners without requiring data on explicit barriers imposed. These are found to reflect the SPS and TBT regulations investigated above, although they are a much broader measure of restrictiveness. Finally, we use the structure of our model to compute the domestic level of restrictiveness g_{jj} and associated iceberg trade costs (τ_{ij}).

4.1.1 Data and Estimation of Baseline Parameters

We merge the EDD data described above with gravity data from CEPII's Geography and TRADHIST databases,[30] as well as manufacturing data from the World Development Indicators (WDI) to produce employment (proxy for country size, L) and gross output (GO) in manufacturing.[31] Current tariff levels (t_{ij}) are taken directly from data, with the full matrix of tariffs from WITS in the year 2011.

We compute the trade shares using data on international trade flows: $\lambda_{ij} = \frac{X_{ij}}{\sum_i X_{ij}}$, where X_{ij} is the value of sales from i to j. Producing the full matrix of λ_{ij} requires a few extra computational steps because we are missing direct data on: i) a "rest of the world" (ROW) country which makes up for all of the rest of trade not captured within our sample (to make trade shares realistic); and ii) domestic trade. The process is as follows. For each destination, its domestic absorption C_j, is measured as $C_j = GO_j + M_j - X_j$, where the last two components reflect total imports ($\sum_{i \neq j} X_{ij}$) and exports ($\sum_{j \neq i} X_{ji}$). Domestic trade is backed out as: $X_{jj} = GO_j - X_j$. Finally, given $\sum_{i \in s} X_{ij}$ as trade flows to destination j *within our sample,* s, exports from ROW to j are the difference between C_j and $\sum_{i \in s} X_{ij}$. Thus, trade shares sum to one, and we can use this procedure to compute trade flows into the ROW as well.[32]

Regardless of our estimation of λ_{ij}, wages and per capita income are easily backed out through (11) and (13) using trade share, employment, and tariff data. Tables 5-6 in the Appendix report the trade shares matrix and estimated wages and income for the sample of countries in the counterfactual.

Finally, to estimate κ and γ, we use a census of Chilean firms in 2012 provided by the Chilean statistics database (INE) and follow Macedoni and Weinberger (2022) to estimate these parameters (plus its domestic restrictiveness) with a cross-section of sales data.[33] With 2012 cross-sectional data of the firm sales distribution, our calibration results in $\kappa = 3.96$

[30]See Head and Mayer (2014) and Fouquin and Hugot (2016).

[31]Domestic trade shares require gross output of manufacturing, which we approximate as in Fernandes et al. (2018) by multiplying the manufacturing value added in each country (from WDI) by 4. In an alternative exercise, we use reported gross output from CEPII's TradeProd database, but this is only available up to 2006 (and for many countries one must go further back).

[32]An alternative approach is to use the trade shares estimated by the gravity equation. We do not employ this approach because it leads to some improbable trade shares due to the representation of countries in our sample. For example, in our sample, Denmark would have a domestic share equal to 0.99, with slightly more realistic shares for countries like Chile, Peru and Bolivia. See Appendix 6.9 for details.

[33]Details are provided in the cited paper, but we summarize the exercise in Appendix 6.6. Chile is the one country for which we have the full census for domestic sales. With those, we match moments from the *domestic* sales distribution (similar to the export moments above). The Chilean census (we use only 2012 for the present paper) can be found from the INE here: https://www.ine.cl/estadisticas/economicas/manufactura?categoria=Encuesta%20Nacional%20Industria%20Anual%20-%20ENIA. Since 2008, the INE publishes the census of manufacturing firms, but without firm indicators. We do not require a panel data.

and $\gamma = 1.88$ (see Appendix 6.6). In the next steps of our estimation procedure we will produce iceberg trade costs and restrictiveness measures from the structure of the model.

4.1.2 Estimation of Country-Pair Restrictiveness

The EDD provides several statistics from the distribution of sales for firms in origin i and destination j which we use to estimate g_{ij} for each country pair. As is argued above, the regulations not only eliminate low-quality firms but reallocate resources to higher-quality firms. Therefore, relative sales of firms selling in j across percentiles of the sales distribution are a function of g_{ij}. The EDD, with information on the distribution of exporters from an origin to multiple destinations, allows us to match moments informative of the imposition of restrictions on destination sales.

For each country pair in our sample $i - j$ we simulate draws of quality conditional on firms exporting to the destination, and compute revenues relative to the average revenue in the destination by firms from the same origin. We compute 6 moments and match them to the data using g_{ij} (taking as given γ and κ). The moments are: the 25th, 50th, and 75th percentiles of sales normalized by average sales, along with the export share of top 1%, 5%, and 25% of exporters. In all cases, the distribution is based on a specific $i - j$ country pair. A simulated method of moments (SMM) algorithm returns a vector of g_{ij} for each $i \neq j$.[34] However, the moments above are not useful for the *domestic* level of restrictiveness g_{jj}, since the EDD data is not informative on this front. We deal with the estimation of g_{jj} in section 4.1.3, but note that the full matrix of estimated restrictiveness measures is reported in Appendix Table 7.

Estimated Restrictiveness and the Extensive Margin. To get a sense of the ability to estimate restrictiveness, we compare our results of the estimated restrictiveness, g_{ij}, with the NTM data used in (1). First, notice that from equation (9) we can derive the ratio of the number of exporters from i across two destinations:

$$\frac{N_{ij}}{N_{ik}} = \left(\frac{w_j t_{ik} \tau_{ik} g_{ik}}{w_k \tau_{ij} t_{ij} g_{ij}} \right)^{\kappa}. \tag{21}$$

We therefore repeat the exercise from (1), but with estimated g_{ij}. If the estimation described above is indeed picking up the restrictiveness as defined in the model, then we should once again find that the number of exporters to j decreases with restrictiveness in that destination,

[34] For details on the SMM procedure, see Appendix 6.6. All 6 moments are not necessarily available for each pair. For each pair, we estimate g_{ij} with the available moments, as long as at least one is reported.

and that the value per exporter increases with restrictiveness (due to the selection of higher quality exporters).

We start by estimating g_{ij} for importer-exporter-product combinations since this is available in the EDD database. Relative to Section 2, we aggregate HS products to 15 "sections" in order to observe sales distributions with more exporters, and reduce the computational cost of estimating so many restrictiveness parameters.[35] Table 2 roughly follows the specifications from Table 1. With product-level observations, we control for exporter-HS Section fixed effects, along with either only destination or importer-destination fixed effects. Either way, we capture variation in the restrictiveness of destinations for the same importer-product exports. Column (1) includes the gravity controls, and we confirm that a rise in g_{ij} reduces the number of exporters to a destination. In this sample, the gravity variables also have the expected sign, as for example, the number of exporters is reduced with distance. In column (2), we check the *intensive margin*, or the export value per exporter. We find that a higher restrictiveness is associated with a larger amount of average exports, consistent with the selection present in the model – regulations select for higher quality exporters. For these first set of results we do not include "Access" controls as the non-tariff measures are only available for a subset of the EDD sample used above.

The last 2 columns in Table 2 compare the model-implied estimated restrictiveness with the technical measures we use to proxy these in Section 2. These include importer-exporter interacted fixed effects, and therefore no gravity controls, in order to compare the most restrictive specifications. First, notice that in the model sample ("Model Estimation"), the coefficient on g_{ij} is still negative and large (column (3)), although smaller than column (1). In this case, we add the full set of controls. Next, we run the same regression with the TM data described in Section 2. In this sample, we still find that a higher prevalence of TMs are associated with fewer exporters to the destination.[36] In fact, destinations with more TMs have a larger estimated g_{ij}, confirming that TMs are one type of standard that we pick up in our general restrictiveness estimate.[37] The counterfactual presented in the next subsection requires a substantially restricted sample, but the results in this table serve as confirmation that our estimated restrictiveness in fact captures a reduction in entry from i to j.[38]

[35]These are a subset of the 21 HS-Sections as classified by the UN (see Appendix 6.6 for a list).

[36]The number of observations are smaller in this case because it requires a country to be included in the NTM-MAP dataset.

[37]We do point out that a 1% rise in the prevalence of TMs seems to have a smaller effect on the number of exporters as a 1% rise in g_{ij}, which is not surprising as the estimated restrictiveness is a broader measure.

[38]We have checked however that the negative relationship exists in the evolving samples.

Table 2: Estimated Restrictiveness and Extensive Margin

	Log N Exporters	Exports per Exporter	Log N Exporters	
	(Model Estimation)	(Model Estimation)	(Model Estimation)	(NTM Data)
Estimated g (log)	-0.541***	0.290***	-0.302***	
	(0.016)	(0.021)	(0.021)	
TM Prevalence (log)				-0.055***
				(0.013)
Log Dist	-0.961***	-0.078***		
	(0.011)	(0.013)		
Border	0.473***	0.286***		
	(0.034)	(0.037)		
Common Language	0.930***	-0.356***		
	(0.026)	(0.026)		
Fixed Effects	j,i-HS	j,i-HS	i-j,i-HS	i-j,i-HS
Controls			Access	Access
R^2	0.768	0.725	0.912	0.908
# Observations	18856	18639	8233	8233

In this table we test whether the estimated restrictiveness, g_{ij}, have the expected effect on the extensive and intensive margin of exporters. The main independent variable in the first three columns is the estimated g_{ij} from the SMM procedure with EDD data. In the first two columns we use all available estimated g_{ij}s, and control only for gravity measures. Column (1) has number of exporters as the outcome and column (2) has mean exports per exporter (both from EDD). In column (3) we repeat column (1) but with a reduced sample that include the NTM data. In this case, we control for tariffs and non-tariff measures that are not technical measures, plus origin-destination and destination-sector fixed effects. Finally, in column (4) we repeat the previous specification with TM prevalence data from Table 1. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

4.1.3 Estimation of Domestic Restrictiveness

The next step is to use the gravity relationships in our model to estimate *domestic* level of restrictiveness, g_{jj}, which cannot be inferred from the exporter data used to estimate g_{ij}. Our method to estimate the domestic level of restrictiveness requires a reference country k. Let Chile be country k, for which we have an estimate of g_{kk} from the Macedoni and Weinberger (2022) procedure mentioned above. In that paper, we describe an algorithm to estimate the domestic level of restrictiveness along with κ and γ, which results in $g_{kk} = 1.066$.

Given an estimation of κ, γ, and g_{kk} for $k = Chile$, we next turn to information about relative trade costs. First, the ratio of the number of exporters from i across two different destinations is derived from (9). We obtain the relative iceberg trade costs $\frac{\tau_{ij}}{\tau_{ik}}$ with the following extensive margin specification:

$$\ln \frac{N_{ij}}{N_{kj}} = \ln S_i - \ln S_k - \kappa \ln \frac{\tau_{ij}}{\tau_{kj}} - \kappa \ln \frac{t_{ij}}{t_{kj}} - \kappa \ln \frac{g_{ij}}{g_{kj}} \tag{22}$$

where S_i and S_k are country i and k fixed effects (which include wages from (21 above)), $\frac{g_{ij}}{g_{kj}}$ are taken from the SMM estimation for $\forall i \neq j$ in Section 4.1.2, and the number of exporters is data from EDD. Trade costs take the following form: $\tau_{ij} = \beta_1 \ln dist_{ij} + \beta_2 contig_{ij} + \beta_3 commlang_{ij} + \beta_4 colony_{ij}$[39], and since we know κ, we then obtain predicted values of $\frac{\tau_{ij}}{\tau_{kj}}$ by estimating the parameters of the equation above.

[39] The latter three variables are equal to one if the country pair shares a border, has a common language, or a colonial relationship, respectively. The first variable is the log distance between the pair in miles.

Given relative trade costs, the domestic levels of restrictiveness can be backed out from the relationships in the model. The relationship between g_{ij} and g_{jj} is given by (6). For exposition purposes, suppose the fixed costs are expressed in destination labor units.[40] Our relationship becomes:

$$g_{ij} - 1 = (g_{jj} - 1)\frac{w_j c_j}{\tau_{ij} w_i c_i} t_{ij}^{-\frac{\gamma}{1+\gamma}} \tag{23}$$

Let $a_i = w_i c_i$, and let us normalize, without loss of generality $a_k = 1$ for Chile. This implies setting its wage to one, and assuming that all marginal costs are expressed as relative to the marginal costs of country Chile. Thus, we have:

$$g_{ij} - 1 = (g_{jj} - 1)\frac{a_j}{\tau_{ij} t_{ij}^{\frac{\gamma}{1+\gamma}} a_i}$$

We can obtain each value of a_i simply by taking the following ratio:

$$\frac{g_{ij} - 1}{g_{kj} - 1} = \frac{\tau_{kj} t_{kj}^{\frac{\gamma}{1+\gamma}}}{\tau_{ij} t_{ij}^{\frac{\gamma}{1+\gamma}}} \frac{1}{a_i} \tag{24}$$

Since we have the estimated values of g_{ij} for each country pair and relative trade costs, $\frac{\tau_{kj} t_{kj}^{\frac{\gamma}{1+\gamma}}}{\tau_{ij} t_{ij}^{\frac{\gamma}{1+\gamma}}}$, we compute g_{jj} as the solution to[41]:

$$\frac{g_{ij} - 1}{g_{ik} - 1} = \frac{g_{jj} - 1}{g_{kk} - 1} \frac{\tau_{ik} t_{ik}^{\frac{\gamma}{1+\gamma}} a_j}{\tau_{ij} t_{ij}^{\frac{\gamma}{1+\gamma}}} \tag{25}$$

4.2 Counterfactual Analysis

Given the procedure outlined in the previous section, we are now armed with the necessary parameters and initial values to compute (15)-(18) for a given change in regulations or tariffs. Before we proceed to our counterfactual exercises, let us briefly discuss the sample of countries we use in the counterfactual analysis. First, we must eliminate all observations from the EDD where a country is not a destination for Chile.[42] To run the counterfactual described in Section 3.3.1 requires an N by N matrix, but the EDD data has more destinations

[40] This algorithm would support also the more general case where the fixed cost is expressed both in domestic and foreign labor units, bundled together in a Cobb-Douglas fashion: $f_{ij} = w_i^{\alpha} w_j^{1-\alpha}$.

[41] Notice that the relationship above is over-identified, so we estimate the parameters by minimizing the sum of squared errors.

[42] In robustness exercises below, we consider alternative strategies.

that origins.[43] In order to estimate g_{jj} we further restrict the data such that we only keep country pairs in which both $i-j$ and $j-i$ exist in the EDD data. With this further restriction we are left with only 16 origins and destinations, and these will make up our hypothetical world in estimating the global welfare effects of a rise in regulations.[44]

4.2.1 Welfare Effects of Regulations and Size of Externality

We next turn to compute the optimal non-cooperative standards in each country implied by our model, taking as given the current policy by other countries. For example, Chile maximizes its welfare by setting its optimal domestic restrictiveness ($g_{chile,chile}$), which then affects the restrictiveness perceived by its trading partners ($g_{i,chile}$) through (25), but it does not incorporate changes in policy abroad.[45] Similarly, we compute unilateral optimal tariffs as those that maximize welfare given initial values for other variables. The counterfactuals estimate the following: what are the welfare gains from moving to optimal standards and optimal tariffs, either starting from a laissez-faire policy, or from the current policies.

Figure 4 presents the counterfactual welfare changes under several scenarios. In panel (A), we compare always to the case where the policy is laissez-faire (i.e. welfare gain of optimal standards/tariffs starting from $g_{ij} = 1, t_{ij} = 1, \forall i, j$).[46] The left figure computes the welfare gain of countries setting their optimal standards, while the right figure is for optimal tariffs. In both cases, the x-axis assumes country j imposes their optimal policy and the rest do nothing. The y-axis is the change in welfare when all countries impose their optimal domestic standard/tariff at the same time, though unilaterally. Notice this is different than a theoretical cooperative equilibrium where countries choose regulations by jointly maximizing welfare. We explore that case in the next subsection.

In the theory, optimal standards increase with income and size, but decrease with openness, and these relationships hold when we examine the welfare changes in the x-axis of Panel (A), left figure. Colombia, with the highest domestic share, has among the highest optimal standards. Costa Rica, which is extremely open, has the lowest optimal standard

[43]There are a select number of countries for which the EDD data collects information about exporters (the origins in the data). We restrict the origins to be those that have exporters in Chile, which limits the sample somewhat. Finally, most destinations (richer countries) are not origins in this data set which is the main reason our sample decreases.

[44]This is a consequence of working with the EDD data, where the sample of exporter origins comes from mostly small developing countries. However we are not aware of any other dataset that contains the type of extensive margin information we require.

[45]As discussed above, when we consider the Nash equilibrium, the best response of the home economy is largely independent of the regulation imposed by the foreign economy (Figure 8), which is why we allow countries to set their optimal standards independently.

[46]In Table 8 of the Appendix, the first four columns report the domestic trade share (λ_{jj}), current restrictiveness on domestic firms (g_{jj}), the optimal domestic standard imposed in a country, and the optimal tariff (imposed on all trade partners).

and thus lowest possible welfare gains away from laissez-faire. The role of size and income is seen for example in comparing Spain and Mexico, which have similar openness, but optimal standards are slightly larger in Spain.

The rationale for cooperation, explored more directly in the next subsection, is captured by allowing all countries to raise their restrictiveness to the optimal standard at once (y-axis). The welfare gains in this case are on average 3 times larger than the gains when countries impose regulations one at a time. Every country in the sample has larger welfare gains in the latter case, reflecting the fact if other countries raise their standards (they are all doing so), there are positive externalities.[47]

Open economies such as Costa Rica, due to their integration with the rest of the world, gain the most from other countries imposing stricter standards relative to imposing their own standards. One can see similar dynamics in destinations like Ecuador and Bolivia. Relatively closed economies, such as Colombia, have a higher optimal restrictiveness and therefore gain more from simply imposing stricter standards even if other countries do not. A similar argument applies for rich/large countries, such as Spain, Mexico, and Denmark.

Although the magnitudes of the welfare gains are not large numbers, an important caveat is that they are lower bounds due to the way we characterize standards as fixed costs that are paid in wages. Regulations that affect the selection of firms without the imposition of a fixed cost paid by *all* firms generate much larger gains as shown by Macedoni and Weinberger (2022).[48] However, we highlight the large benefits available to countries in *jointly* raising standards. An important result emphasized here is countries do not internalize all the benefits from raising standards domestically, which provides a motivation to negotiate "deep" trade agreements.

Standards policy can also be compared to other parts of the policy schedule, such as tariffs. The plot on the right of panel (A) in Figure 4 displays the gains from optimal tariffs relative to free trade, in the cases where firms act unilaterally from free trade and in the case where all firms set their optimal tariff. As expected, there are clear incentive for countries to impose positive tariffs unilaterally, and in fact welfare gains can be quite large.[49] However, there is an important difference relative to standard policy, which is that the higher tariffs have large negative effects on trade partners. In the case where all countries impose optimal tariffs, everyone is worse off than laissez faire. In this sense the global push to eliminate tariffs is rationalized and there is a clear case for the type of cooperation seen since the

[47]The last three columns of Table 8 list the welfare changes under these scenarios and the ratio of the case when all countries impose their optimal regulation relative to when countries imposes them independently.

[48]One might imagine that the compliance costs can be at least partially transferred back to consumers, reducing the wastefulness of these costs.

[49]The optimal tariff on average is 36%.

1980s.

Panel (B) of Figure 4 provides a perspective of possible gains available in altering *current policies on standards*. We compare this to the case of removing current tariffs. The x-axis displays the change in welfare for each country when all tariffs are eliminated, relative to keeping current tariffs. The y-axis reports welfare changes for the case when each country sets their optimal standards (together but not cooperatively), again relative to their currently estimated restrictions.

For the majority of countries, changing standards results in larger welfare gains than all tariffs being removed. Notice that in this case countries can either raise or lower their standards depending on whether their current restrictiveness levels are too high or too low.[50] An advantage of our quantitative exercise is to identify in which direction countries should take their policies. Very open countries such as Costa Rica gain more from tariff reductions (and don't gain as much from standards), while more closed economies such as Colombia, Peru, and Uruguay gain relatively more from standards policy. In a world where current tariffs are already quite low, we have once again rationalized the recent push towards product standard regulation.

Robustness Exercises. The exercise above is limited by various data restrictions, thus we investigate alternative exercises with differing data assumptions and an alternative data set in Appendix 6.8.

4.3 Benefits from Cooperation

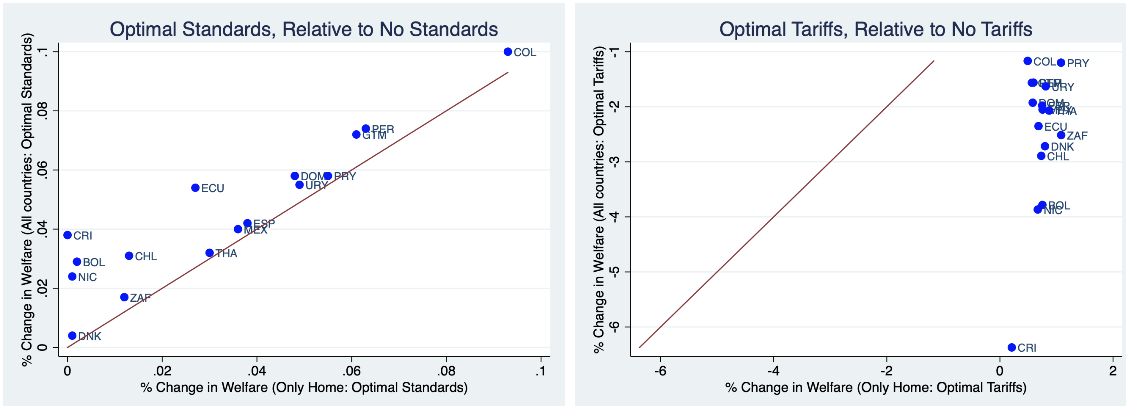
The previous results highlight that regulations create additional benefits that are not internalized by the country imposing the regulation. Each country sets their *own* optimal policy taking as given the current standards, and since most countries choose to raise their standards, the gains are on average 3 times larger compared to when countries raise standards individually. However, the cooperative equilibrium might allow for even larger gains. When each country sets its optimal policy non-cooperatively, further restrictions will lower its terms of trade, this effect will dominate, and thus welfare decreases. With cooperation, countries can choose their domestic policies jointly in a way that lessens the terms of trade effect while also raising both countries' welfare due to the entry of high-quality firms.[51]

[50] For example, Costa Rica among a few others, is a country where the current domestic restrictiveness we estimate is *above* the optimal (see Table 8). In this case, it is possible for welfare to decrease in some countries as their trade partners reduce their standards (even though they are moving to their optimal policy). In our sample, this is seen only in Denmark.

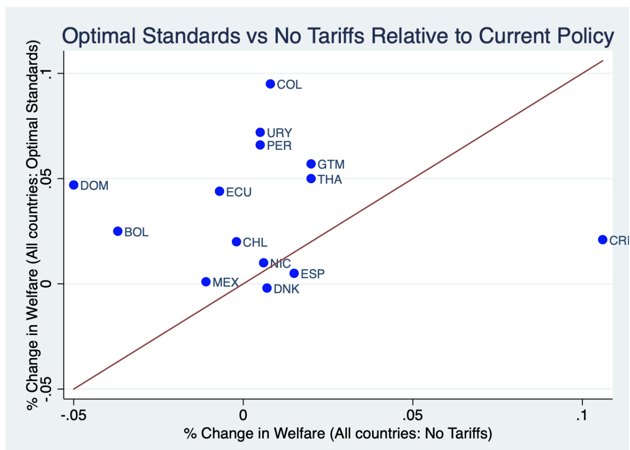
[51] A similar dynamic, where countries coordinate their industrial subsidies to limit the detrimental terms of trade movement, exists in Lashkaripour and Lugovskyy (2021).

Figure 4: % Change in Welfare for Changes in Restrictiveness and Tariffs

(A) Optimal Standards and Tariffs relative to Laissez-Faire: All Countries set Policy vs One at a Time



(B) Optimal Standards and No Tariffs relative to Current Policy: All Countries set Policy vs One at a Time



This figure displays the % change in welfare for countries in several scenarios. In **panel (A)**, we compare always to the case where the policy is laissez-faire (i.e. welfare gain of optimal standards/tariffs starting from no standards/no tariffs). The left figure computes the welfare gain of countries setting their optimal standards, while the right figure is for optimal tariffs. In both cases, the x-axis assumes country j imposes their optimal policy and the rest do nothing. The y-axis is the change in welfare when all countries impose their optimal domestic standard/tariff. In **panel (B)**, we compare the welfare gain of moving from the *current policy* (currently estimated standards/measured tariffs) to either optimal standards (y-axis) or no tariffs (x-axis). Notice that the new standard policy can reduce welfare in this case as a country's trade partners now might reduce their standards to their own optimal level. In all cases, after altering policy through either $\hat{g_{ij}}$ or $\hat{t_{ij}}$, we then compute $\hat{J_j}$, $\hat{w_j}$, $\hat{y_j}$ and $\hat{\lambda_{ij}}$ as a response, which produces the equivalent variation in income according to (20).

In the following we conduct a two-country exercise, such that a "deep" trade agreement where each country promises a certain level of restrictiveness is more plausible. For exposition purposes we conduct the exercise with Chile and Ecuador, so that each partner has a significant presence in the other country. In this two-country case, we first recalculate the optimal domestic standard for each country taking the current level of its partner country standard as given – or the non-cooperative case.[52] Then, cooperation allows them to sign

[52]We also re-scale trade shares assuming these countries only trade with each other.

a binding agreement where each country sets a domestic standard such that *joint welfare* is maximized. Total welfare depends on the weights given to the welfare change in each country, which we vary from the extreme case where Ecuador receives 80% of the weight to the case where Chile receives 80% of the weight.[53]

Recall that in Section 3, we explore two mechanisms that shape the optimal standard under cooperation. First, we show that under symmetry across countries, the cooperative standard is larger than the non-cooperative one. Second, we show that a country's optimal standard depends on the country's technology and size. Hence, when two asymmetric countries cooperatively choose their standards, the first mechanism tends to raise their restrictiveness, while the second tends to make the standards more in line with each country's preferences. By changing the weight on each country in maximizing joint welfare, we illustrate such a trade off with a practical exercise.

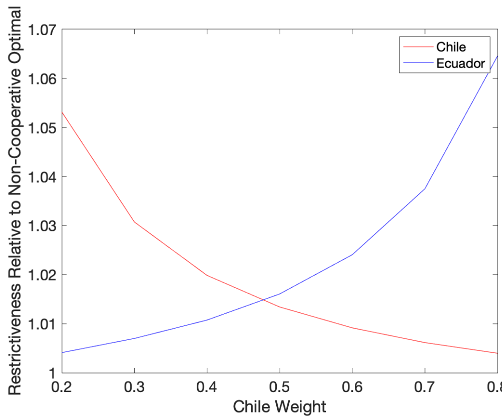
The gains from cooperation are displayed in Figure 5. The left panel plots the agreed upon domestic restrictiveness in each country relative to their optimal restrictiveness in the non-cooperative case. The right panel plots the welfare gains in each country relative to the non-cooperative case (but where each applies their optimal standard independently at the same time). In both cases, the x-axis is the range of weights given to Chile's welfare in the agreement (with Ecuador's weight equal to one minus Chile's).

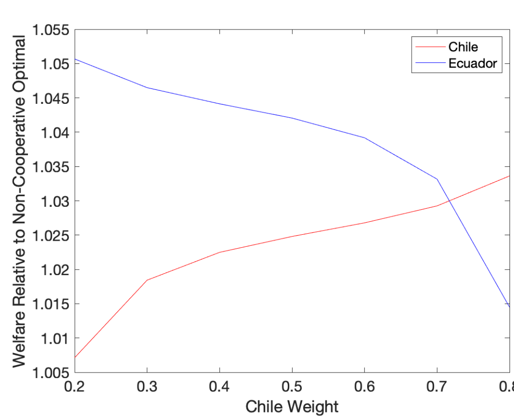
It is clear that by cooperating, they both choose to set higher standards and the welfare of both countries increases significantly as long as each country gets a large enough weight. Intuitively, each country gains when its partners' standards increase, but the reduction in the terms of trade reduces their welfare as their own standard increases. When Chile's weight is very small, the agreement is such that Ecuador marginally raises its standard but Chile does so much more significantly. In this case, although the weighted average welfare change is maximized, Chile's welfare is essentially equal to the non-cooperative case while Ecuador's increases significantly. As Chile's weight increases, its own standard decreases while Ecuador's increases, which also raises Chile's welfare. In the case where the weights are equal, both countries set a standard around 2% larger than the non-cooperative case[54] and welfare increases in both countries. Ecuador *gains more* from the cooperation because of the relative trade shares: Chile's firms have more presence in Ecuador than vice-versa.

[53]To be clear, the dynamic examined here is not limited to the two country case. However, illustrating the channels becomes less transparent as the number of countries in the agreement increases.

[54]Note that it is not the case that at equal weights countries necessarily raise standards by same amount.

Figure 5: The Role for Cooperation: Optimal Restrictiveness, g_{jj}^{opt}, (left) and Welfare Gains (right), relative to Non-Cooperation in 2-country Case (for varying weights on Chile).





The figures display the relative restrictiveness and welfare gains when countries cooperate in a 2-way agreement, relative to the countries (at the same time) setting their own optimal rate. We assume a 2 country world where Chile and Ecuador enter into a trade agreement that sets the level of domestic restrictiveness in each country. We calculate the non-cooperative optimal restrictiveness for each country in this 2-country scenario, then we compare that to the case where they maximize joint welfare, while varying the weights for each country. In both figures, the x-axis is a range of weights given to Chile's welfare in the agreement (with Ecuador's weight equal to one minus Chile's). In the left figure, the y-axis is the ratio of the domestic restrictiveness in each country relative to their non-cooperative optimal. In the right figure, the y-axis is the welfare in each when they maximize joint welfare relative to when both countries impose their optimal non-cooperative standard.

5 Conclusions

We have studied the effects of regulations that affect the selection of firms in an open economy framework. The framework not only includes estimated bilateral trade costs but allows countries to adjust tariffs from their current levels. Regulations improve the efficiency of allocation of production across firms that are heterogeneous in quality: as low-quality firms over-produce in the market allocation, regulations that force their exit improve welfare. We show that there is a positive optimal standard for all countries even allowing for the loss of variety and wastefulness of the fixed cost, but our main result is that higher standards improve the welfare of trade partners as well. The possible welfare gains are larger than eliminating current tariffs across the board. For this reason, the paper justifies trade agreements on standards on the basis of a positive externality and extends the role of cooperation to efficiency considerations. Cooperation across countries ensures higher welfare achieved with higher levels of regulations.

Our framework allows us to compare the optimal degree of restrictiveness of standards that countries of different characteristics impose. We find that larger countries and countries with a higher level of average quality optimally choose more restrictive standards. This result is consistent with our evidence the large, richer, and less open economies tend to impose a larger number and more restrictive technical standards. The quantitative exercise highlights the mechanisms present in the model and provides estimates of possible welfare gains.

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6 Appendix

6.1 Data Appendix

NTM-MAP Database The database is available at http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=28 and described in ?. It computes a frequency index, coverage ratio and prevalence score of non-tariff measures (NTMs) for 71 countries at the HS2 and HS-Section level of product aggregation. It produces separate measures for different types of NTMs. For our "product standard" regulations, we add the prevalence measures of SPS and TBT measures. In the "other NTMs" control, we sum up the prevalence measures for the rest of the NTMs included. We use only the measures reported in 2012.

Exporter Dynamics Database (EDD) The EDD is a dataset from the World Bank that draws on the universe of exporter transactions obtained directly from customs agencies. We use the HS2 level data, which reports the number of exporters from an origin country to many destinations at this product classification. It also includes several measures of the intensive margin, in terms of the mean, median, etc. of export values across exporters. There are 45 origins in the EDD data and 70 destinations. We can match the vast majority of destinations to our NTM data, but if we wanted a measure of the barriers imposed by the origin we would only be able to do this for less than half the countries. In this case, we split the EU into separate countries to take advantage of variation in trade flows to separate European destinations. When possible, we use the data in 2012. For certain countries, data is only available for previous years, in which case we use the latest available year. If no data is available before 2010 we drop that country. Finally, we only keep country-pairs where there are at least 200 total exporters from the origin selling to that destination (across all products). This database is also used in the estimation procedure described in Section 4.

Other Datasets

- PTW Data, version 9.0, available at https://www.rug.nl/ggdc/productivity/pwt/pwt-releases/pwt9.0?lang=en. From this dataset we use the following variables: population, real GDP at constant prices (both total and per capita), and the share of imports and exports in real GDP. The latter two variables are used to construct an openness measure which is the simple average of the two. For the full sample of countries, we create 3 bins that separate countries based on real GDP, GDP per capita, population, and openness.

- Gravity Data: This comes from the GeoDist database available at CEPII: http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=6. We use the commonly used measures of distance as well as indicators for country-pairs based on whether they share a border, share a language, or share a common colonial history.

- Tariff Data: imported from the WITS database.

- Trade flows used to construct trade shares are from the BACI database in CEPII: http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=37.

6.2 Stylized Facts Robustness

Table 3 replicates columns (6) and (7) of the benchmark table, but with the regulations of "similar" countries (in terms of sharing a border/language/legal origin) as instruments, both separately and in an over-identified specification. We control for tariffs but not "other" non-tariff measures, since these might suffer from the same endogeneity concern this IV specification aims to control for. We do confirm that the number of exporters is lower when there are more TMs imposed, and the coefficient increases relative to the OLS specification. In both cases the F-stat is large which suggests a strong instrument. The fourth column reports an over-identified specification where we use both instruments, with the results mirroring the first column. Furthermore, the Hansen J-Statistic suggests we cannot reject the null of valid instruments at the 5% level and we also find that an endogeneity test *cannot* reject the null that the number of regulations is exogenous. The last column repeats the specification for average exports as the LHS, and once again there is no strong evidence for either a positive or negative effect on exports per exporter.

Table 3: Trade Margins and Regulations: IV

	Log Number of Exporters				Log Value per Exporter
	(Border)	(Language)	(Legal)	(OverID)	(Border)
TM Prevalence (log)	-0.157***	-0.254**	-0.953***	-0.154***	-0.145
	(0.042)	(0.103)	(0.284)	(0.044)	(0.109)
F-stat (first stage)	1210.17	195.24	41.45	346.30	1210.17
Fixed Effects	i-j,i-hs2	i-j,i-hs2	i-j,i-hs2	i-j,i-hs2	i-j,i-hs2
Controls	Tariffs	Tariffs	Tariffs	Tariffs	Tariffs
# Observations	27101	23229	28602	21901	27101

In this table we use an IV specification to study the effect that destination-specific regulation have on the number of exporters and exports per exporter. The first four columns follow the specification in column (6) of Table 1, while the last column replicates column (7) of that table. In each case, TM_{js} is instrumented by measures applied in "related" countries. We instrument the number regulations in each destination in three ways: the average number of regulations in the same sector, for countries that either share a border, have a common language, or a common legal origin with the instrumented country. In the "OverID" columns we instrument using all three IVs. In all cases, we control for origin-destination and origin-sector fixed effects. We control for tariffs but not "other" non-tariff measures since these might suffer from the same endogeneity concern this IV specification aims to control for. The first-stage F-statistic is reported. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

6.3 Model Derivations

6.3.1 Consumer Problem

We adopt a special case of the Generalized Translated Power (GTP) preferences proposed by Bertoletti and Etro (2020). Consumers in each country j have the following utility function:

$$U_j = \int_{\Omega_j} \left(az(\omega)\xi_j q(\omega) - \frac{(\xi_j q(\omega))^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}} \right) d\omega + \frac{\xi_j^{-\eta} - 1}{\eta} \tag{26}$$

where $a > 0$ and $\gamma \geq 0$ are constants, $q(\omega)$ is the quantity consumed of variety ω, $z(\omega)$ is a variety specific demand shifter, which we interpret as quality, and Ω_j is the set of varieties available for consumption. ξ_j is a quantity aggregator that is implicitly defined as:

$$\xi_j^{-\eta} = \int \left(az(\omega)\xi_j q(\omega) - (\xi_j q(\omega))^{1+\frac{1}{\gamma}} \right) d\omega \tag{27}$$

The GTP utility follows the generalized Gorman-Pollak demand system[55], and nests several of the most commonly used non-homothetic and homothetic preferences based on the value of the parameter $\eta \in [-1, \infty]$.[56]

In this paper, we fix $\eta = -1$, to obtain Indirectly Additive (IA) preferences as described by Bertoletti et al. (2018). This choice guarantees that our model remains highly tractable while maintaining enough flexibility to match the data well. We emphasize that our con-

[55] Gorman (1972), Pollack (1972).

[56] For $\eta = 0$, preferences become homothetic with a single aggregator, as in Translog (Feenstra, 2003). For $\eta \to \infty$, preferences become directly additive (DA), and generalize the preferences used by Melitz and Ottaviano (2008) (MO). MO requires that $\gamma = 1$ to generate linear demand. The case of $\eta = -1$ is described below. Fally (2018) describes the regularity conditions for these preferences.

clusion is not qualitatively affected by the choice of IA preferences and refer the reader to Macedoni and Weinberger (2022) for the quantitative differences across preferences as determined by the choice of η.

The consumer's budget constraint is:

$$\int_{\Omega_j} p(\omega)q(\omega)dz \leq y_j$$

where $p(\omega)$ is the price of variety ω. The consumer chooses $q(\omega)$, $\omega \in \Omega_j$, to maximize its utility subject to the budget constraint, which generates the inverse demand stated in the main text.

6.3.2 Firm Problem

Given the quality draw z, a firm from i maximizes its profits in a destination j by choosing the quantity $q_{ij}(z)$ and taking ξ_j as given. Operating profits (net of the fixed costs) are given by:

$$\begin{aligned}\tilde{\pi}_{ij}(z) &= L_j\left[\frac{p_{ij}(z)}{t_{ij}}q_{ij}(z) - c_i w_i \tau_{ij} q_{ij}(z)\right] = \\ &= L_j\left[\frac{y_j}{t_{ij}}\left(azq_{ij}(z) - (\xi_j)^{\frac{1}{\gamma}}\left(q_{ij}(z)\right)^{1+\frac{1}{\gamma}}\right) - \tau_{ij} w_i c_i q_{ij}(z)\right]\end{aligned} \tag{28}$$

The first order condition with respect to $q_{ij}(\omega)$ equals:

$$\frac{y_j}{t_{ij}}az - \frac{y_j}{t_{ij}}\left(1+\frac{1}{\gamma}\right)\left(\xi_j q_{ij}(z)\right)^{\frac{1}{\gamma}} = \tau_{ij} w_i c_i$$

and setting $q_{ij}(z^*_{ij}) = 0$ yields the market determined quality cutoff as in the main text:

$$z^*_{ij} = \frac{t_{ij}\tau_{ij} w_i c_i}{a y_j} \tag{29}$$

Substituting the cutoff (3) into the first order condition yields the optimal quantity:

$$q_{ij}(z) = \left(\frac{a\gamma}{1+\gamma}\right)^{\gamma}\frac{(z^*_{ij})^{\gamma}}{\xi_j}\left(\frac{z}{z^*_{ij}} - 1\right)^{\gamma} \tag{30}$$

Substituting (30) into (2) yields the optimal pricing rule:

$$p_{ij}(z) = \frac{a y_j z^*_{ij}}{1+\gamma}\left(\frac{z}{z^*_{ij}} + \gamma\right) \tag{31}$$

Prices are increasing in per capita income of the destination, but are unresponsive to market size, in line with the evidence from Simonovska (2015) and Dingel (2017). Furthermore, prices are increasing in quality z. Such prediction receives empirical support from Bastos and Silva (2010), Martin (2012), and Manova and Zhang (2017). Firm z revenues $r_{ij}(z)$ and profits $\pi_{ij}(z)$ are given by:

$$r_{ij}(z) = \left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j y_j (z_{ij}^*)^{1+\gamma}}{\xi_j t_{ij}}\right)\left(\frac{z}{z_{ij}^*}-1\right)^{\gamma}\left(\frac{z}{z_{ij}^*}+\gamma\right) \tag{32}$$

$$\tilde{\pi}_{ij}(z) = \left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j y_j (z_{ij}^*)^{1+\gamma}}{\xi_j t_{ij}}\right)\left(\frac{z}{z_{ij}^*}-1\right)^{1+\gamma} \tag{33}$$

6.3.3 Aggregation and Equilibrium

Aggregate revenues (net of tariffs) of firms from i to country j are given by:

$$\begin{aligned}
R_{ij} &= N_{ij}\int_{\bar{z}_{ij}}^{\infty} r_{ij}(z)\frac{\kappa \bar{z}_{ij}^{\kappa}}{z^{\kappa+1}}dz = \\
&= N_{ij}\left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j y_j (z_{ij}^*)^{1+\gamma}}{\xi_j t_{ij}}\right)\int_{\bar{z}_{ij}}^{\infty}\left(\frac{z}{z_{ij}^*}-1\right)^{\gamma}\left(\frac{z}{z_{ij}^*}+\gamma\right)\frac{\kappa \bar{z}_{ij}^{\kappa}}{z^{\kappa+1}}dz = \\
&= N_{ij}\left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j y_j (z_{ij}^*)^{1+\gamma}}{\xi_j t_{ij}}\right)G_2(g_{ij}) = \\
&= \left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j y_j (z_{ij}^*)^{1+\gamma-\kappa}}{\xi_j t_{ij} g_{ij}^{\kappa}}\right)J_i b_i^{\kappa} G_2(g_{ij}) = \\
&= \left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j y_j (z_{jj}^*)^{-\kappa+1+\gamma}}{\xi_j (c_j w_j)^{-\kappa+1+\gamma}}\right)(\tau_{ij}c_i w_i)^{-\kappa+\gamma+1} t_{ij}^{-\kappa+\gamma} J_i b_i^{\kappa} g_{ij}^{-\kappa} G_2(g_{ij})
\end{aligned}$$

where we used the definition of quality cutoff $z_{ij}^* = z_{jj}^* \frac{t_{ij}\tau_{ij}c_i w_i}{c_j w_j}$. $G_2(g_{ij})$ is given by:

$$G_2(g_{ij}) = \kappa g_{ij}^{\gamma}\left[\frac{g_{ij}\,{}_2F_1[\kappa-\gamma-1, -\gamma; \kappa-\gamma, g_{ij}^{-1}]}{\kappa-\gamma-1} + \frac{\gamma\,{}_2F_1[\kappa-\gamma, -\gamma; \kappa-\gamma+1, g_{ij}^{-1}]}{\kappa-\gamma}\right]$$

where ${}_2F_1[a, b; c, d]$ is the hypergeometric function.

The sum of sales (including tariffs) across origins to destination j is then:

$$\sum_i t_{ij}R_{ij} = \left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j y_j (z_{jj}^*)^{-\kappa+1+\gamma}}{\xi_j (c_j w_j)^{-\kappa+1+\gamma}}\right)\sum_i (t_{ij}\tau_{ij}c_i w_i)^{-\kappa+\gamma+1} J_i b_i^{\kappa} g_{ij}^{-\kappa} G_2(g_{ij}) \tag{34}$$

Hence, the gravity equation is represented by the following expression for the trade share, which we reported in the main text:

$$\lambda_{ij} = \frac{t_{ij} R_{ij}}{\sum_v t_{vj} R_{vj}} = \frac{(t_{ij}\tau_{ij}c_i w_i)^{-\kappa+\gamma+1} J_i b_i^\kappa g_{ij}^{-\kappa} G_2(g_{ij})}{\sum_v (t_{ij}\tau_{vj}c_v w_v)^{-\kappa+\gamma+1} J_v b_v^\kappa g_{vj}^{-\kappa} G_2(g_{vj})}$$

By market clearing, total sales in a destination equal the total income of that destination, i.e., $\sum_i t_{ij} R_{ij} = y_j L_j$. Thus, we obtain:

$$\left(\frac{a^{1+\gamma}\gamma^\gamma}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j y_j (z_{jj}^*)^{-\kappa+1+\gamma}}{\xi_j (c_j w_j)^{-\kappa+1+\gamma}}\right) = L_j y_j \left[\sum_i (t_{ij}\tau_{ij}c_i w_i)^{-\kappa+\gamma+1} J_i b_i^\kappa g_{ij}^{-\kappa} G_2(g_{ij})\right]^{-1} \tag{35}$$

Average profits from i to j are:

$$\begin{aligned}
\bar{\pi}_{ij} &= \int_{\bar{z}_{ij}}^{\infty} \pi_{ij}(z) \frac{\kappa \bar{z}_{ij}^\kappa}{z^{\kappa+1}} dz - f_{ij} = \\
&= \left(\frac{a^{1+\gamma}\gamma^\gamma}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j w_j (z_{ij}^*)^{1+\gamma}}{\xi_j}\right) \int_{\bar{z}_{ij}}^{\infty} \left(\frac{z}{z_{ij}^*} - 1\right)^{1+\gamma} \frac{\kappa \bar{z}_{ij}^\kappa}{z^{\kappa+1}} dz - f_{ij} = \\
&= \left(\frac{a^{1+\gamma}\gamma^\gamma}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j w_j (z_{ij}^*)^{1+\gamma}}{\xi_j}\right) G_1(g_{ij}) - f_{ij} = \\
&= \left(\frac{a^{1+\gamma}\gamma^\gamma}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j w_j (z_{ij}^*)^{1+\gamma}}{\xi_j t_{ij}}\right) (G_1(g_{ij}) - (g_{ij}-1)^{1+\gamma})
\end{aligned}$$

where we used (5) and where $G_1(g_{ij})$ is given by:

$$G_1(g_{ij}) = \kappa g_{ij}^\gamma \left[\frac{g_{ij}\,{}_2F_1[\kappa-\gamma-1, -\gamma; \kappa-\gamma, g_{ij}^{-1}]}{\kappa-\gamma-1} - \frac{{}_2F_1[\kappa-\gamma, -\gamma; \kappa-\gamma+1, g_{ij}^{-1}]}{\kappa-\gamma}\right]$$

Let $\tilde{G}_1(g_{ij}) = g_{ij}^{-\kappa}[G_1(g_{ij}) - (g_{ij}-1)^{1+\gamma}]$ and $\tilde{G}_2(g_{ij}) = g_{ij}^{-\kappa} G_2(g_{ij})$. Expected profits from i to j equals:

$$\begin{aligned}
E[\pi_{ij}] &= \left(\frac{b_i}{\bar{z}_{ij}}\right)^\kappa \bar{\pi}_{ij} = b_i^\kappa (z_{ij}^*)^{-\kappa} g_{ij}^{-\kappa} \bar{\pi}_{ij} = \\
&= \left(\frac{a^{1+\gamma}\gamma^\gamma}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j w_j (z_{ij}^*)^{-\kappa+1+\gamma}}{\xi_j t_{ij}}\right) b_i^\kappa g_{ij}^{-\kappa} (G_1(g_{ij}) - (g_{ij}-1)^{1+\gamma}) = \\
&= \left(\frac{a^{1+\gamma}\gamma^\gamma}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j y_j (z_{jj}^*)^{-\kappa+1+\gamma}}{\xi_j (c_j w_j)^{-\kappa+1+\gamma}}\right) (\tau_{ij} c_i w_i)^{-\kappa+\gamma+1} t_{ij}^{-\kappa+\gamma} b_i^\kappa \tilde{G}_1(g_{ij}) = \\
&= \frac{L_j y_j (\tau_{ij} c_i w_i)^{-\kappa+\gamma+1} t_{ij}^{-\kappa+\gamma} b_i^\kappa \tilde{G}_1(g_{ij})}{\sum_i (t_{ij}\tau_{ij} c_i w_i)^{-\kappa+\gamma+1} J_i b_i^\kappa g_{ij}^{-\kappa} G_2(g_{ij})}
\end{aligned}$$

where we used (35). Using our gravity equation (10), the expected profits can be written as:

$$E[\pi_{ij}] = L_j y_j \frac{\lambda_{ij}}{J_i t_{ij}} \frac{\tilde{G}_1(g_{ij})}{\tilde{G}_2(g_{ij})} \tag{36}$$

The zero expected profit condition yields the expression for the equilibrium mass of firms:

$$\sum_j E[\pi_{ij}] = w_i f_E$$

$$\sum_j L_j y_j \frac{\lambda_{ij}}{J_i t_{ij}} \frac{\tilde{G}_1(g_{ij})}{\tilde{G}_2(g_{ij})} = w_i f_E$$

$$J_i = \frac{1}{w_i f_E} \sum_j \frac{\lambda_{ij}}{t_{ij}} y_j L_j \frac{\tilde{G}_1(g_{ij})}{\tilde{G}_2(g_{ij})} \quad \forall i = 1, ..., I \tag{37}$$

which is the expression shown in the main text.

Per capita income is given by:

$$y_j = w_j + \frac{1}{L_j} \sum_i (t_{ij} - 1) R_{ij}$$

$$y_j = w_j + y_j \sum_i (t_{ij} - 1) \frac{\lambda_{ij}}{t_{ij}}$$

which is the expression shown in the main text.

Let us now consider the utility function. Substituting the definition of the aggregator ξ into the utility function yields:

$$U_j = \int_{\Omega_j} \left(a z(\omega) \xi_j q(\omega) - \frac{\xi_j q(\omega))^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}} \right) d\omega - (\xi_j - 1) = \int_{\Omega_j} \frac{(\xi_j q(\omega))^{1+\frac{1}{\gamma}}}{1+\gamma} d\omega + 1$$

$$= \left(\frac{a\gamma}{1+\gamma} \right)^{1+\gamma} \sum_{i=1,h} z_{ij}^{\gamma+1} N_{ij} \int_{\bar{z}_{ij}}^{\infty} \left(\frac{z}{z_{ij}^*} - 1 \right)^{1+\gamma} \frac{\kappa \bar{z}_{ij}^{\kappa}}{z^{\kappa+1}} dz + 1$$

Thus the utility becomes:

$$U_j = 1 + a^{\kappa} \left(\frac{\gamma}{1+\gamma} \right)^{1+\gamma} \sum_i J_i b_i^{\kappa} \left(\frac{t_{ij} \tau_{ij} w_i c_i}{y_j} \right)^{-\kappa+\gamma+1} g_{ij}^{-\kappa} G_1(g_{ij})$$

From our gravity equation:

$$J_i b_i^{\kappa} \left(\frac{t_{ij} \tau_{ij} w_i c_i}{y_j} \right)^{-\kappa+\gamma+1} g_{ij}^{-\kappa} = \frac{\lambda_{ij}}{\lambda_{jj}} J_j b_j^{\kappa} \left(\frac{\tau_{jj} c_j w_j}{y_j} \right)^{-\kappa+\gamma+1} g_{jj}^{-\kappa} \frac{G_2(g_{jj})}{G_2(g_{ij})}$$

Thus, subtracting one from our utility, we obtain:

$$\tilde{U}_j = U_j - 1 = a^{\kappa} \left(\frac{\gamma}{1+\gamma} \right)^{1+\gamma} \frac{J_j b_j^{\kappa} \left(\tau_{jj} c_j w_j / y_j \right)^{-\kappa+\gamma+1}}{\lambda_{jj}} \tilde{G}_2(g_{jj}) \sum_i \frac{\lambda_{ij} G_1(g_{ij})}{G_2(g_{ij})}$$

6.3.4 Equivalent Variation in Income

First, consider the indirect utility function written as:

$$V(W_j, \mathbf{p}) = \frac{1}{1+\gamma} \sum_i N_{ij} \int_0^{\bar{z}_{ij}} \left(\xi_j q_{ij}(z) \right)^{1+\frac{1}{\gamma}} f(z) dz = \frac{1}{1+\gamma} \sum_i N_{ij} \int_0^{\bar{z}_{ij}} \left(az - \frac{p_{ij}(z)}{W_j} \right)^{1+\gamma} f(z) dz$$

where $W_j = y_j + EV_j$ and EV_j is the equivalent variation in income. Taking logs and differentiating with respect to W_j holding prices constant yields:

$$d \ln V_j = (1+\gamma) \frac{\sum_i N_{ij} \int_0^{\bar{z}_{ij}} \left(az - \frac{p_{ij}(z)}{W_j} \right)^{\gamma} \frac{p_{ij}(z)}{W_j} f(z) dz}{\sum_i N_{ij} \int_0^{\bar{z}_{ij}} \left(az - \frac{p_{ij}(z)}{W_j} \right)^{1+\gamma} f(z) dz} d \ln W_j$$

Substituting prices yields:

$$d \ln V_j = (1+\gamma) \frac{\sum_i N_{ij} (z_{ij}^*)^{1+\gamma} \int_0^{\bar{z}_{ij}} \left(\left(1 + \gamma - \frac{y_j}{W_j} \right) \frac{z}{z_{ij}^*} - \gamma \frac{y_j}{W_j} \right)^{\gamma} \frac{y_j}{W_j} \left(\frac{z}{z_{ij}^*} + \gamma \right) f(z) dz}{\sum_i N_{ij} (z_{ij}^*)^{1+\gamma} \int_0^{\bar{z}_{ij}} \left(\left(1 + \gamma - \frac{y_j}{W_j} \right) \frac{z}{z_{ij}^*} - \gamma \frac{y_j}{W_j} \right)^{1+\gamma} f(z) dz} d \ln W_j$$

Solving the expression generates hypergeometric functions that depend both on g_{ij} and EV_j. Integrating for $EV_j \in [0, W_j - y_j]$ yields the equivalent change in welfare. However, such an expression is quite complicated and requires numerical integration. Thus, we use the local approximation, which can be obtained by setting $y_j = W_j$. This yields:

$$\begin{aligned} d \ln V_j &= (1+\gamma) \frac{\sum_i N_{ij} (z_{ij}^*)^{1+\gamma} \int_0^{\bar{z}_{ij}} \left(\frac{z}{z_{ij}^*} - 1 \right)^{\gamma} \left(\frac{z}{z_{ij}^*} + \gamma \right) f(z) dz}{\sum_i N_{ij} (z_{ij}^*)^{1+\gamma} \int_0^{\bar{z}_{ij}} \left(\frac{z}{z_{ij}^*} - 1 \right)^{1+\gamma} f(z) dz} d \ln W_j = \\ &= (1+\gamma) \frac{\sum_i J_i b_i^{\kappa} (t_{ij} \tau_{ij} c_i w_i)^{1+\gamma} g_{ij}^{-\kappa} G_2(g_{ij})}{\sum_i J_i b_i^{\kappa} (t_{ij} \tau_{ij} c_i w_i)^{1+\gamma} g_{ij}^{-\kappa} G_1(g_{ij})} d \ln W_j = \\ &= (1+\gamma) \frac{\sum_i \lambda_{ij}}{\sum_i \lambda_{ij} \frac{G_1(g_{ij})}{G_2(g_{ij})}} d \ln W_j = \\ &= (1+\gamma) \left[\sum_i \lambda_{ij} \frac{G_1(g_{ij})}{G_2(g_{ij})} \right]^{-1} d \ln W_j \end{aligned}$$

Thus, to compute the welfare change given $\hat{\hat{U}}$, we calculate:

$$d \ln W_j = \frac{\sum_i \lambda_{ij} \frac{G_1(g_{ij})}{G_2(g_{ij})}}{1+\gamma} (\hat{\hat{U}} - 1)$$

6.4 Welfare Effects of Regulations

We consider the case of two symmetric countries, where only one of them (home) is allowed to impose a regulation. The parameters are as follows: $\kappa = 4$, $\gamma = 1.5$, $\lambda_{hh} = \lambda_{ff} = 0.65$. In the initial equilibrium the two countries are identical and size and per capita income are normalized to one. In the initial equilibrium, there are no regulations and there is a symmetric level of tariffs $t_{hf} = t_{fh} = 1.01$. The iceberg trade costs are derived using the gravity equations and the numerical values for trade shares and tariffs. Figure 6 illustrates the effects of increase in restrictiveness of the standard on several outcome variables. Figure 7 displays results for the case in which firms must pay the fixed cost of compliance in *destination* labor units. Namely, $f_{hh} = w_h f$ and $f_{fh} = w_f f = f$. This change in the assumption does not alter the results in any relevant way. Furthermore, in this case of symmetric countries, the plots look virtually identical to the case of fixed costs in source labor units. The reason for that is due to the fact that home wages change minimally in the range of regulations considered and, therefore, such a change is not enough to produce visible changes in optimal policy.

Figure 6: Effects of Regulations (Fixed Cost in Source Labor Units)

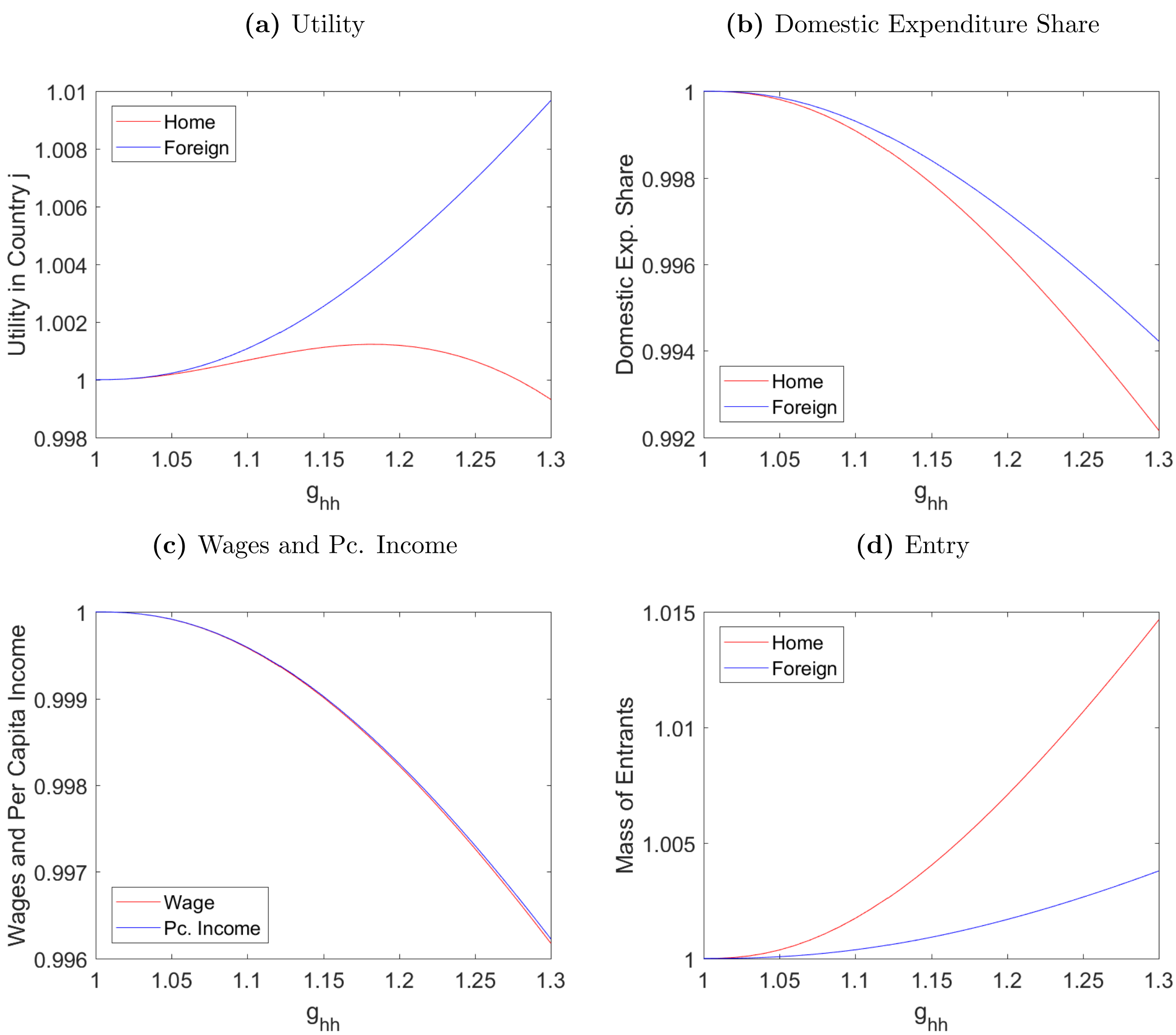


Figure 7: Effects of Regulations (Fixed Cost in Destination Labor Units)

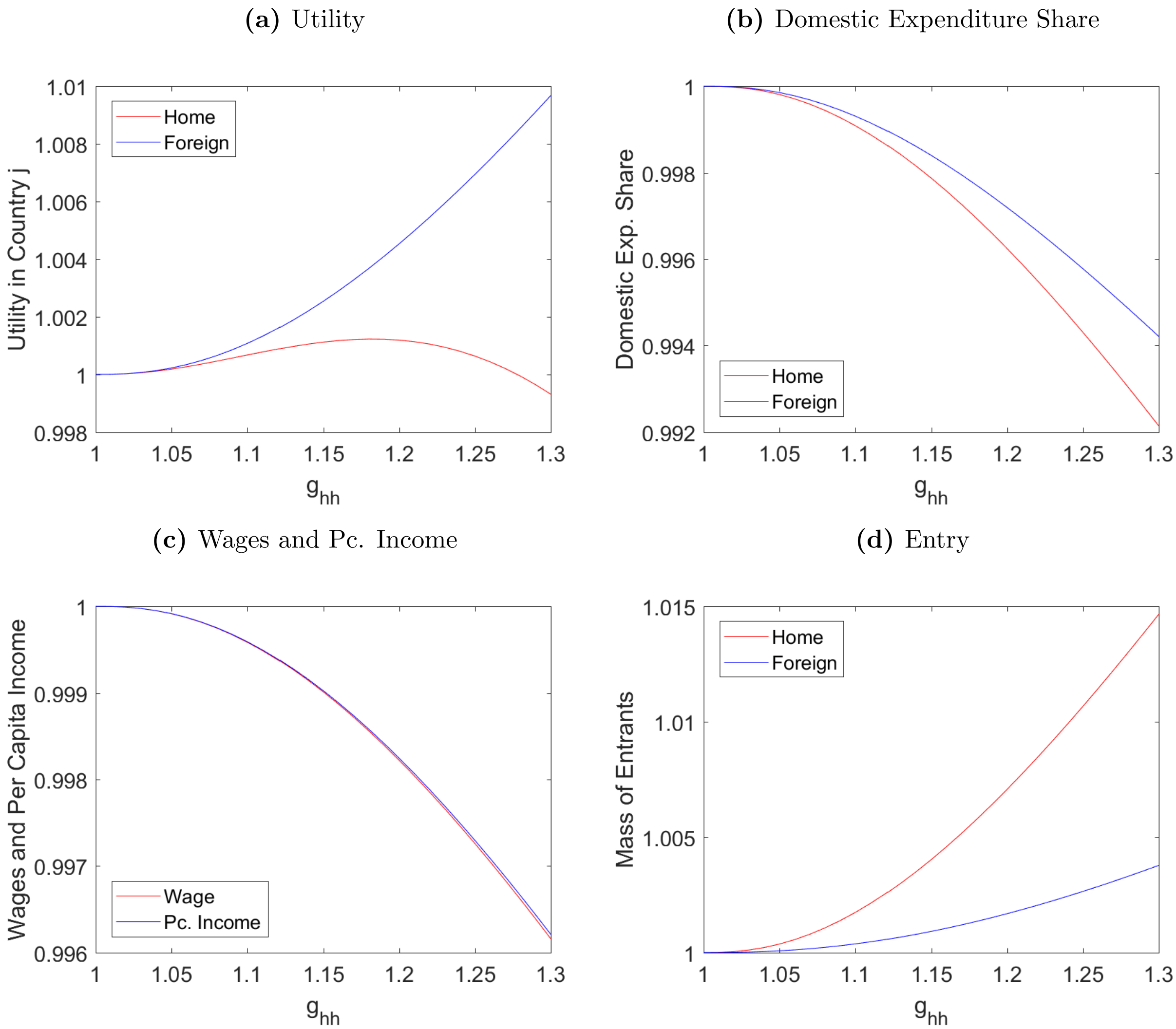
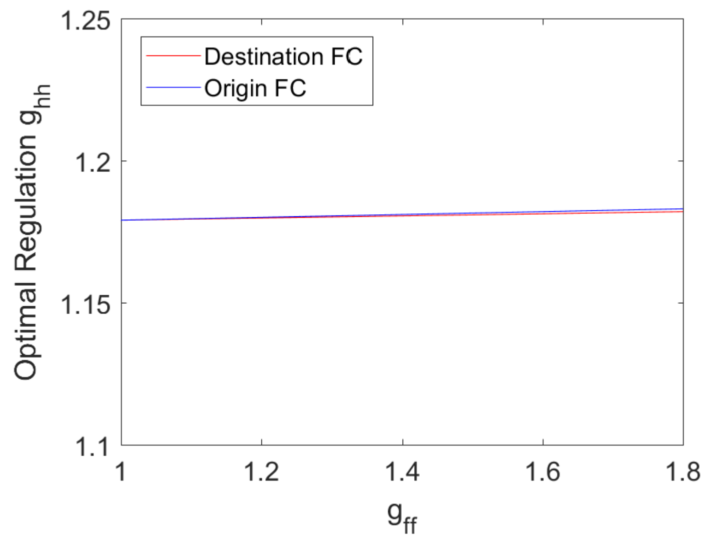
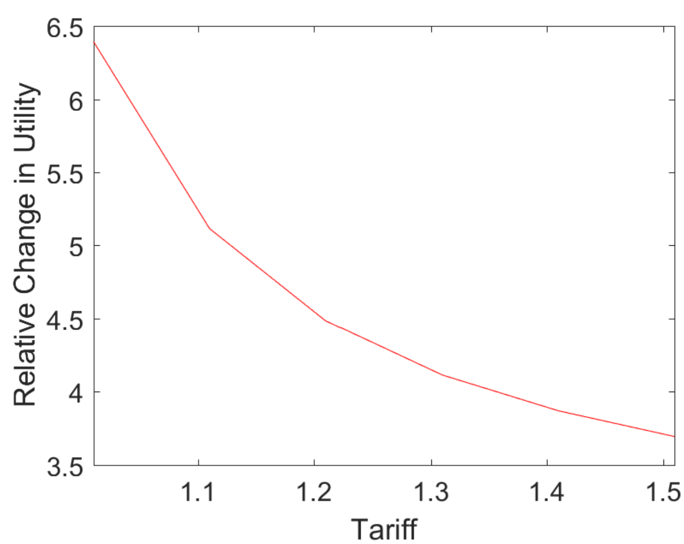


Figure 8: Best Response



The figures plots the optimal level of regulation of the home economy (vertical axis), given a level of restrictiveness of regulation of the foreign economy (horizonthal axis).

Figure 9: Restrictiveness of Regulation and Home Welfare - Cooperation

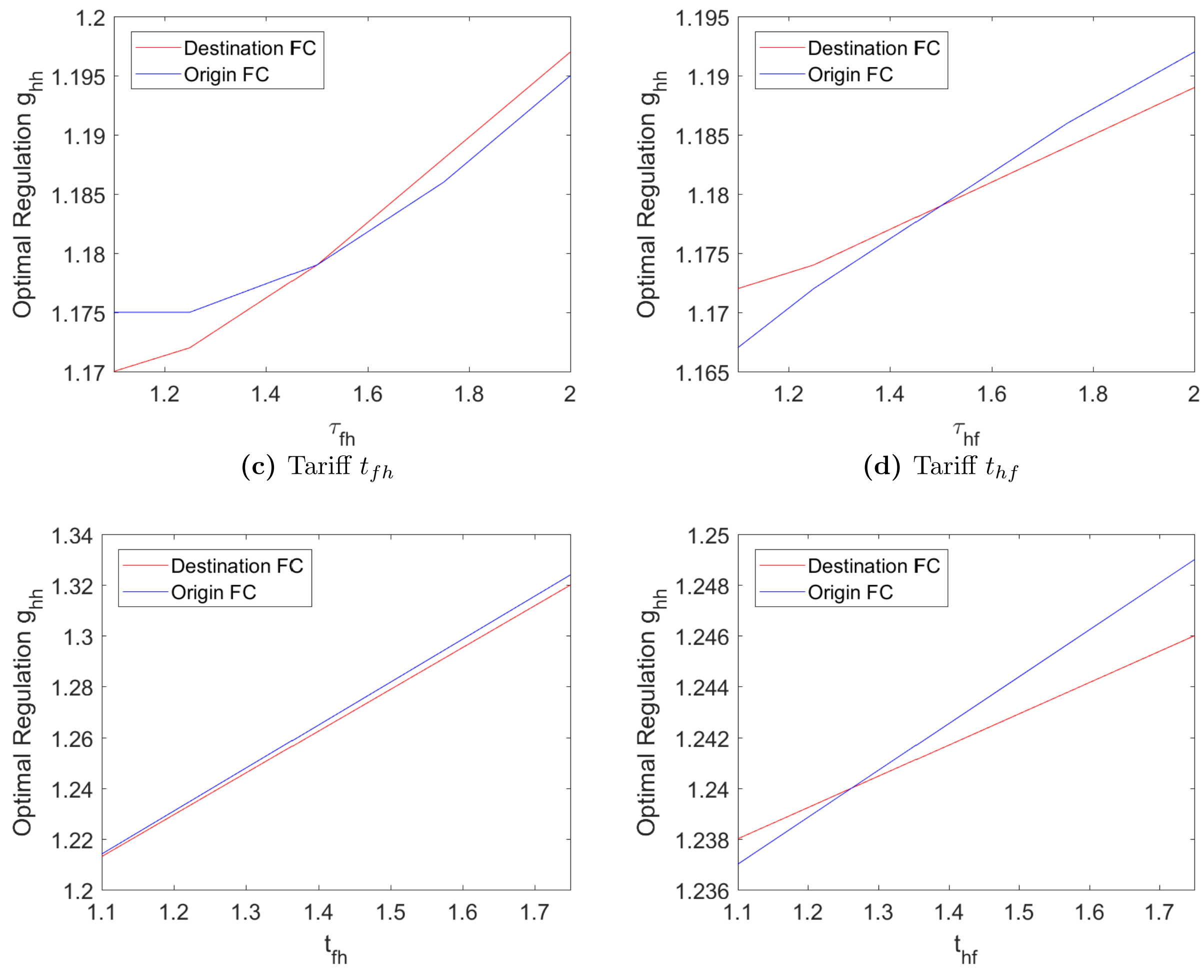


The figures plot $\hat{U} - 1$ for the home economy due to the imposition of the optimal regulation under cooperation relative the unilateral imposition of the regulation, at different values of tariffs.

Figure 10: Optimal Regulation and Iceberg Trade Costs

(a) Trade Cost τ_{fh} **(b)** Trade Cost τ_{hf}

(c) Tariff t_{fh} **(d)** Tariff t_{hf}



6.4.1 Mapping of Fixed Cost in g

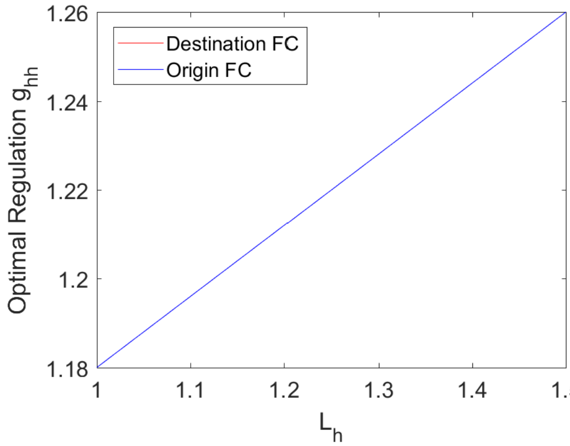
In this section, we show numerically that there is a monotone relationship between the fixed cost f_j and the restrictiveness of regulations g_{jj} in the domestic economy, as well as between g_{jj} and g_{ij}. Hence, we extend the result of Macedoni and Weinberger (2022) to the open economy framework. We do so in the two-country framework used in the previous section.

Let us re-write here the relationship between domestic restrictiveness and fixed costs (5)

$$f_{jj} = \left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j y_j(z_{jj}^*)^{1+\gamma}}{\xi_j t_{jj}}\right)(g_{jj}-1)^{1+\gamma}$$

Figure 11: Optimal Regulation, Size, and Costs

(a) Home Size



(b) Home Unit Costs

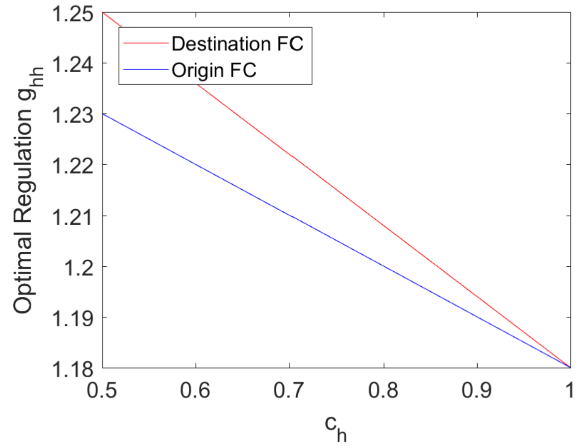
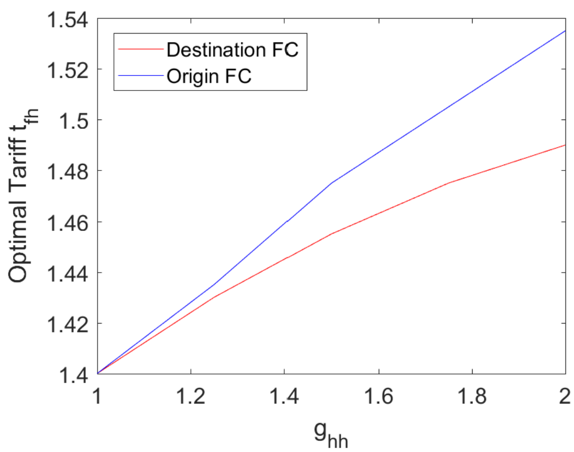


Figure 12: Optimal Tariff



Notice that:

$$\left(\frac{a^{1+\gamma}\gamma^{\gamma}}{(1+\gamma)^{1+\gamma}}\right)\left(\frac{L_j y_j (z_{jj}^*)^{1+\gamma}}{\xi_j t_{jj}}\right) = \frac{R_{ij}}{N_{ij} G_2(g_{ij})}$$

Hence, our definition can be re-written as:

$$f_{jj} = \frac{R_{jj}\left(g_{jj}-1\right)^{1+\gamma}}{N_{jj} G_2(g_{jj})}$$

From the gravity equation definition:

$$R_{jj} = \frac{\lambda_{jj} y_j L_j}{t_{jj}}$$

Furthermore,

$$N_{jj} = J_j b_j^{\kappa} (g_{jj} z_{jj}^*)^{-\kappa}$$

and

$$z_{jj}^* = \frac{t_{jj}\tau_{jj}w_j c_j}{a y_j}$$

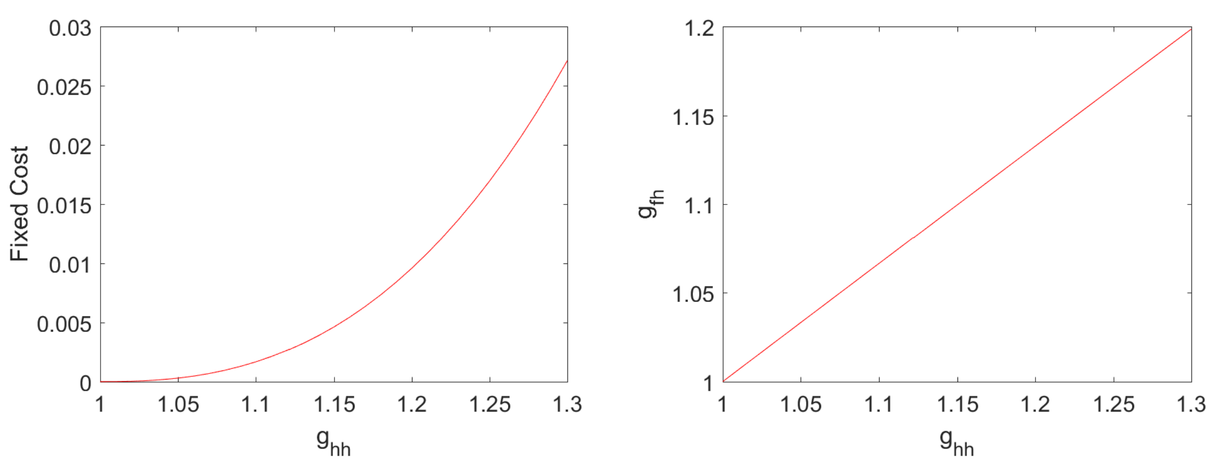
Finally, $f_{jj} = f_j w_j$. Hence, we can write the fixed cost f_j as:

$$f_j = \frac{R_{jj}\left(g_{jj}-1\right)^{1+\gamma}}{w_j N_{jj} G_2(g_{jj})} \tag{38}$$

where total sales R_{ij} and mass of surviving firms N_{jj} are defined above and depend on the equilibrium variables computed in the previous section. Using the same parameters adopted in the previous section, we show that there is a one-to-one mapping of the fixed cost into the restrictiveness of regulations g_{hh} and g_{fh}. We show here the results in the case in which the fixed costs are expressed in destination labor units. This assumption only affects panel (b), i.e., the relationship between g_{hh} and g_{fh}. However, the results are robust to changing this assumption.

Figure 13: Fixed Cost and Regulatory Restrictiveness

(a) Fixed Cost f_j **(b)** Restrictiveness g_{fh}



6.5 Consumption Externality

In this section, we consider an extension to the baseline model in which consumption is associated with an externality that depends on product quality. We examine how the externality interacts with the optimal level of restrictiveness of the regulation. We adopt the functional form of Macedoni and Weinberger (2022) and write the utility of the representative consumer as:

$$\tilde{U}_j = U_j + \ln(E_j) \tag{39}$$

where E_j is the externality associated with the consumption of goods of higher quality and is modeled as quantity weighted average quality:

$$E_j = \frac{\sum_i \int_{\bar{z}_{ij}}^{\infty} q_{ij}(z) z^{\beta} dz}{\sum_i \int_{\bar{z}_{ij}}^{\infty} q_{ij}(z) dz} \tag{40}$$

where β controls the relationship between z and the consumption externality. For $\beta > 0$, larger values of z are associated with a larger positive externality. In this case, society is better off when consumers purchase high-quality goods since high-quality for consumers is also equivalent to higher positive externality, although the externality implies that the average quality in the market is too low regardless of the allocative inefficiencies. For $\beta < 0$, larger values of z are associated with a smaller positive externality. This is the case in which higher firm quality is associated with some negative externality.

Solving the integrals, we obtain:

$$\int_{\bar{z}_{ij}}^{\infty} q_{ij}(z) dz = \left(\frac{a\gamma}{1+\gamma}\right)^{\gamma} \frac{\kappa (z_{ij}^{*})^{-\kappa+\gamma} J_i b_i^{\kappa} g_{ij}^{-\kappa+\gamma}}{\xi_j} \left(\frac{F_2(g_{ij})}{\kappa - \gamma}\right)$$

$$\int_{\bar{z}_{ij}}^{\infty} q_{ij}(z) z^{\beta} dz = \left(\frac{a\gamma}{1+\gamma}\right)^{\gamma} \frac{\kappa (z_{ij}^{*})^{-\kappa+\beta+\gamma} J_i b_i^{\kappa} g_{ij}^{-\kappa+\beta+\gamma}}{\xi_j} \left(\frac{F_1(\beta, g_{ij})}{\kappa - \gamma - \beta}\right)$$

where

$$F_1(\beta, g_{ij}) =_2 F_1(\kappa - \gamma - \beta, -\gamma; \kappa - \gamma - \beta + 1; g_{ij}^{-1})$$

Using the cutoff definition yields:

$$\int_{\bar{z}_{ij}}^{\infty} q_{ij}(z) dz = \left(\frac{a\gamma}{1+\gamma}\right)^{\gamma} \left(\frac{z_{jj}^{*}}{w_j c_j}\right)^{-\kappa+\gamma} \frac{\kappa (t_{ij}\tau_{ij} c_i w_i)^{-\kappa+\gamma} J_i b_i^{\kappa} g_{ij}^{-\kappa+\gamma}}{\xi_j} \left(\frac{F_2(g_{ij})}{\kappa - \gamma}\right)$$

$$\int_{\bar{z}_{ij}}^{\infty} q_{ij}(z) z^{\beta} dz = \left(\frac{a\gamma}{1+\gamma}\right)^{\gamma} \left(\frac{z_{jj}^{*}}{w_j c_j}\right)^{-\kappa+\beta+\gamma} \frac{\kappa (t_{ij}\tau_{ij} c_i w_i)^{-\kappa+\beta+\gamma} J_i b_i^{\kappa} g_{ij}^{-\kappa+\beta+\gamma}}{\xi_j} \left(\frac{F_1(\beta, g_{ij})}{\kappa - \gamma - \beta}\right)$$

Hence, the externality becomes:

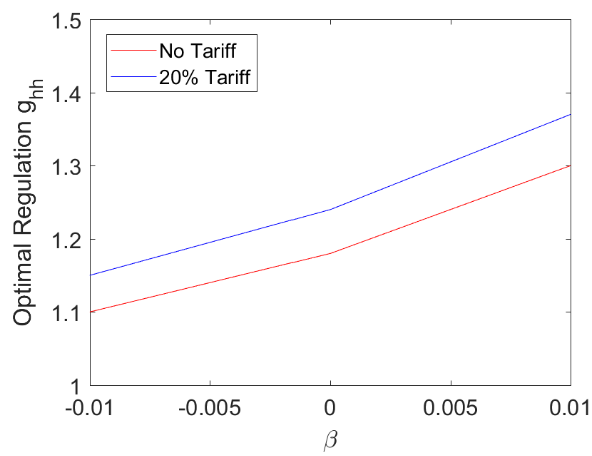
$$E_j = \frac{\kappa - \gamma}{\kappa - \gamma - \beta} \left(\frac{z_{jj}^{*}}{w_j c_j}\right)^{\beta} \frac{\sum_i J_i b_i^{\kappa} g_{ij}^{-\kappa+\beta+\gamma} (t_{ij}\tau_{ij} c_i w_i)^{-\kappa+\beta+\gamma} F_1(\beta, g_{ij})}{\sum_i J_i b_i^{\kappa} g_{ij}^{-\kappa+\gamma} (t_{ij}\tau_{ij} c_i w_i)^{-\kappa+\gamma} F_2(g_{ij})} \tag{41}$$

Using the definition of z^*_{jj} and of the export trade share λ_{ij} we find:

$$E_j = \frac{\kappa-\gamma}{\kappa-\gamma-\beta}\left(\frac{1}{ay_j}\right)^{\beta}\frac{\sum_i \lambda_{ij} g_{ij}^{\beta+\gamma}(t_{ij}\tau_{ij}c_i w_i)^{\beta-1}\frac{F_1(\beta,g_{ij})}{\tilde{G}_2(g_{ij})}}{\sum_i \lambda_{ij} g_{ij}^{\gamma}(t_{ij}\tau_{ij}c_i w_i)^{-1}\frac{F_2(g_{ij})}{\tilde{G}_2(g_{ij})}} \tag{42}$$

We compute the optimal g_{hh} for a two-country model for different values of β. Figure 14 shows that, for positive values of β, the optimal regulation is higher than the baseline case, as the regulation improves allocative efficiency and the externality at the same time. Notice that this result holds regardless of the level of the tariff: the externality increases the optimal level of regulation both in a case of no tariff and in a case in which there is a symmetric tariff of 20%. In contrast, for negative values of β, the regulation worsens the externality, but it improves allocative efficiency and, thus, the optimal regulation is smaller than the baseline case.

Figure 14: Optimal g_{hh} and Externality



6.6 Quantitative Exercise: Simulated Method of Moments Algorithm

Estimation of g_{ij} with EDD Data. The exporter dynamics database provides 6 statistics about the sales distribution, which we could use to estimate g_{ij} for each country pair. In particular, the EDD has:

- Median, First Quartile, and Third Quartile for the export value per exporter distribution (moments of the pdf)
- Share of top 1%, 5%, and 25% of Exporters in total export distribution

So, for each country pair in our sample $i - j$ we simulate draws of quality conditional on firms exporting to the destination, and compute revenues relative to the average revenues: $\frac{r_{ij}(z)}{R_{ij}}$. Armed with these relative revenues for every exporter, we compute 6 moments and match them to the data (taking the values of γ and κ as given). The moments are:

- 25th, 50th, and 75th percentiles of sales normalized by average sales
- Share of top 1%, 5%, and 25% of Exporters in total export distribution

This algorithm returns a vector of g_{ij} for each $i \neq j$. Our identification consists of choosing the parameter set that minimizes the sum of the squared errors between empirical and theoretical moments:

$$\min_{g,\forall i,i\neq j} \sum_{q=1}^{6} \left(F_q^d - F_q^m(g_{ij})\right)^2, \tag{43}$$

where q identifies each of the 6 moments listed above.

Estimation of parameters with Chilean Firm Data. The procedure below is adopted from Macedoni and Weinberger (2022). In that case, we have firm level data which allows us to produce the distribution of *domestic* sales. Domestic sales are a function of g_{jj}, just as as g_{ij} is a function of the export distribution of firms in country i that sell in j. The procedure below takes a closed economy framework where g refers to g_{jj} in the model above, where $j = Chile$.

We adopt an over-identification strategy that targets 99 moments from the empirical domestic sales distribution. Given a set of potential producers in the simulation, namely those with $z > g$, we compute firm revenues normalized by mean revenues:

$$\tilde{r}(z|z > g) = \frac{r}{\bar{r}} = (G_2(g))^{-1} \left(\frac{z}{z^*} - 1\right)^{\gamma} \left(\frac{z}{z^*} + \gamma\right) \tag{44}$$

where $G_2(g)$ is a function that depends on the targeted parameters and $\tilde{r}$ refers to *domestic sales*.

The theoretical relative sales are matched to their counterpart in the data in order to identify the model parameters in an approach that follows Sager and Timoshenko (2019). Let $F_q^m(g, \kappa, \gamma) = \log(\tilde{r})_q$ be the q-th quantile of the simulated log domestic sales distribution. Then, let F_q^d denote the corresponding value of the empirical CDF of the log sales distribution. Our identification consists of choosing the parameter set that minimizes the sum of the squared errors between empirical and theoretical quantiles:

$$\min_{g,\kappa,\gamma} \sum_{q=1}^{99} \left(F_q^d - F_q^m(g, \kappa, \gamma)\right)^2 . \tag{45}$$

The strategy to estimate the parameter set $(\hat{g}, \hat{\kappa}, \hat{\gamma})$ is based on the separate ways that each parameter is identified within the sales distribution. κ governs the shape of the quality distribution, which is proportional to the shape in the sales distribution only in special cases (Mrázová et al., 2021), which do not apply to our model. The divergence in the sales and quality distribution is due to the distribution of markups. Since firm markup levels are a function of γ (see (4)), this parameter affects the mapping from the quality to the sales distribution and is not collinear with κ.[57] Finally, the standard not only eliminates low-quality firms but reallocates resources to higher-quality firms. Therefore, relative sales across percentiles of the sales distribution are a function of g. For this reason, we use a general strategy to match sales across the firm distribution, with each parameter being identified by different parts of the distribution.

HS Sections. For the specification reported in Table 2 we aggregate the HS2 data into "sections". These sections are a subset of the 21 HS-Sections as classified by the UN, as listed along with their description in Table 4 below. We combine the 21 sections into 17 aggregate sections, and have 15 left in our data with positive number of observations.

[57] As is not the case, for example, if preferences were CES and the distribution of quality is Pareto.

Table 4: Correspondence of our Custom HS Sections to UN Classification

This Paper	HS Sec.		ISIC	HS2
1	1	Live Animals; animal products	01, 05	1 to 5
1	2	Vegetable products	15	6 to 14
1	3	Animal or vegetable fats and oils; prepared fats	15	15
2	4	Prepared foodstuffs; beverages, spririts vinegar; tobacco	15,16	16-24
3	5	Mineral products	23	25-27
4	6	Products of chemical or allied industries	24	28-38
5	7	Plastics and articles thereof; rubbers	25	39-40
6	8	Raw hids and skins; leather; handbags; articles of animal gut	18	41-43
7	9	Wood; charcoal; cork; straw; plaiting materials	20	44-46
8	10	Pulp or wood or other cellulosic material;paper or paperboard	21	47-49
9	11	textiles and textile articles	17	50-63
10	12	Footwear, headgear, umbrellas; prepared feathers; flowers, human hair	19	64-67
11	13	Articles of stone, plaster, cement, asbestos, mica, ceramic, glass, wine	26	68-70
12	14	Natural or cultured pearls, precious stones, metals, jewelry	36	71
13	15	base metals and articles of base metal	27	72-83
14	16	machinery and mechanical appliances; electrical equipment	31,28	84-85
15	17	Vehicles, aircraft, transport”	34,35	86-89
16	18	Optical photographic, cinematographic, medical and musical instruments	32,33	90-92
17	19	Arms and ammunition, parts thereof	29	93
12	20	Miscellaneous manufactured products	36	94-96
	21	Works of art, collectors pieces		97-98

6.7 Quantitative Exercise

6.7.1 Trade Share, Wages, Income and Restrictiveness Results

The following tables report the initial values for trade shares, wages and estimated restrictiveness. Methods to compute each of these measures are detailed in the main text.

Table 5: Trade Shares Matrix for all i,j, taken from trade flow data

	BOL	CHL	COL	CRI	DNK	DOM	ECU	ESP	GTM	MEX	NIC	PER	PRY	ROW	THA	URY	ZAF
BOL	0.4557	0.0013	-	-	-	-	-	-	-	-	-	0.0029	-	0	-	-	-
CHL	0.0244	0.5762	0.0032	0.0138	0.0007	0.001	0.0089	0.0018	0.002	0.0013	0.0026	0.0073	0.0034	0.0001	0.0005	0.0036	0.0006
COL	0.0103	0.0121	0.8133	0.0155	-	0.0072	0.0311	0.003	0.0083	0.0008	0.0018	0.0091	0.0005	0.0001	-	0.001	-
CRI	-	0.0002	0.0002	0.1916	-	0.0039	0.0008	0.0001	0.0071	0.0029	0.0452	0.0002	-	0	-	0.0002	-
DNK	0.0006	0.0011	0.0003	0.001	0.5994	0.0012	0.0003	0.0022	0.0001	0.0004	-	0.0004	-	0.0001	0.0004	0.0023	0.0012
DOM	-	-	0.0001	0.0018	-	0.7131	-	0.0001	0.0019	0.0001	-	-	-	0	-	-	-
ECU	0.0021	0.0119	0.0035	0.0013	-	0.0008	0.6468	0.0005	0.0034	0.0001	-	0.0119	-	0	-	-	-
ESP	0.0064	0.0077	0.0026	0.009	0.0061	0.0085	0.0087	0.6915	0.0028	0.0036	0.0104	0.0047	0.002	0.0004	0.0009	0.0037	0.0051
GTM	-	0.0006	0.0002	0.0192	-	0.0018	0.0004	0.0001	0.7496	0.0005	0.0343	0.0005	-	0	-	-	-
MEX	0.0151	0.0144	0.0211	0.0551	0.0008	0.0169	0.0126	0.0066	0.0287	0.6807	0.0433	0.0098	0.0038	0.0006	0.0009	0.0074	0.003
NIC	-	-	-	0.005	-	-	-	-	0.0015	0.0001	0.4308	-	-	0	-	-	-
PER	0.0356	0.0115	0.003	0.0022	-	0.0009	0.016	0.002	0.0017	0.0004	0.0016	0.7548	0.0002	0.0001	-	0.0006	-
PRY	0.0054	-	-	-	-	-	-	-	-	-	-	-	0.7377	0	-	0.002	-
ROW	0.4375	0.3569	0.1509	0.6802	0.3906	0.2437	0.2701	0.29	0.191	0.305	0.4231	0.1943	0.2469	0.9979	0.3314	0.257	0.403
THA	0.0044	0.004	0.0011	0.0043	0.0018	0.0009	0.0044	0.0008	0.002	0.0034	0.0069	0.0026	0.0017	0.0003	0.6631	0.0008	0.0112
URY	0.0023	0.0015	0.0003	-	-	-	-	0.0001	-	0.0003	-	0.001	0.0038	0	-	0.7215	-
ZAF	-	0.0006	0.0001	-	0.0006	-	-	0.001	-	0.0005	-	0.0004	-	0.0002	0.0029	-	0.5758

This table reports trade shares, for our trade matrix. In the cases where there is no exporter information in EDD, we assume no trade between those country pairs (since we cannot estimate g_{ij} in those cases). Trade shares estimated from international trade flow data are equal to: $\lambda_{ij} = \frac{X_{ij}}{\sum_i X_{ij}}$ (where X_{ij} = reflect trade flow data from i to j). Producing the full matrix of λ_{ij} requires a few extra computational steps because we are missing direct data on: i) a "rest of the world" (ROW) country which makes up for all of the rest of trade not captured within our sample (to make trade shares realistic); and ii) domestic trade. The process is as follows. For each destination, its domestic absorption, C_j is measured as $C_j = GO_j + M_j - X_j$, where the last two components reflect total imports ($\sum_{i \neq j} X_{ij}$) and exports ($\sum_{j \neq i} X_{ji}$). Domestic trade is backed out as: $X_{jj} = GO_j - X_j$. Given $\sum_{i \in s} X_{ij}$ as trade to destination j *within our sample, s*, exports from ROW to j are the difference between C_j and the sample exports to j. Thus, trade shares sum to one.

Table 6: Predicted Wages and Income (Market Clearing)

	Wages	Income
BOL	0.170040986	0.170693342
CHL	1	1.002164661
COL	0.65120712	0.651490168
CRI	0.855951039	0.858036764
DNK	4.293177874	4.293566511
DOM	0.295739781	0.296811631
ECU	0.453012817	0.454078352
ESP	1.824774916	1.824896922
GTM	0.27902311	0.279414182
MEX	0.959316854	0.960386899
NIC	0.141852507	0.142274511
PER	0.543505243	0.543883307
PRY	0.315180694	0.315424374
ROW	9.417142154	9.418083868
THA	0.993703775	0.994269049
URY	1.066411722	1.067347472
ZAF	0.603414377	0.604419202

This table reports the estimated wages given employment data, trade shares, and the relationship given by (11). We normalize the wages in Chile equal to one.

Table 7: Estimated Restrictiveness Index (g_{ij}) Matrix for all i,j

	BOL	CHL	COL	CRI	DNK	DOM	ECU	ESP	GTM	MEX	NIC	PER	PRY	ROW	THA	URY	ZAF
BOL	1.33	1.07	-	-	-	-	-	-	-	-	-	1.15	-	1.00	-	-	-
CHL	1.03	1.07	1.01	1.07	1.09	1.16	1.03	1.04	1.09	1.02	1.34	1.01	1.11	1.00	1.49	1.06	1.12
COL	1.00	1.00	1.03	1.00	-	1.00	1.00	1.02	1.00	1.00	1.15	1.00	1.15	1.00	-	1.09	-
CRI	-	1.00	1.00	1.17	-	1.00	1.00	1.03	1.00	1.00	1.00	1.00	-	1.00	-	1.20	-
DNK	1.15	1.47	1.12	1.25	1.08	1.10	3.33	1.12	1.73	1.02	-	1.14	-	1.00	1.33	1.35	1.52
DOM	-	-	1.13	1.07	-	1.10	-	1.05	1.00	1.05	-	-	-	1.00	-	-	-
ECU	1.18	1.06	1.01	1.10	-	1.05	1.10	1.12	1.05	1.16	-	1.00	-	1.00	-	-	-
ESP	1.14	1.00	1.00	1.05	1.00	1.04	1.04	1.27	1.05	1.00	1.05	1.00	1.37	1.00	1.00	1.10	1.00
GTM	-	1.08	1.05	1.00	-	1.00	1.08	1.26	1.11	1.00	1.00	1.03	-	1.00	-	-	-
MEX	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NIC	-	-	-	1.03	-	-	-	-	1.03	1.11	1.01	-	-	1.00	-	-	-
PER	1.00	1.00	1.00	1.01	-	1.02	1.01	1.01	1.00	1.02	1.05	1.06	1.05	1.00	-	1.05	-
PRY	1.44	-	-	-	-	-	-	-	-	-	-	-	2.27	1.00	-	1.27	-
ROW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
THA	1.06	1.00	1.00	1.01	1.00	1.12	1.00	1.00	1.04	1.00	1.22	1.00	1.05	1.00	1.55	1.01	1.00
URY	1.08	1.08	1.20	-	-	-	-	1.15	-	1.09	-	1.76	1.09	1.00	-	1.63	-
ZAF	-	1.03	1.01	-	1.04	-	-	1.00	-	1.00	-	1.04	-	1.00	1.00	-	1.85

This table reports estimated restrictiveness (g_{ij}) for all country pairs available in EDD. In the cases where there is no exporter information in EDD, we assume no trade between those country pairs (since we cannot estimate g_{ij} in those cases).

6.7.2 Welfare Results

The following tables present summary statistics on domestic trade shares, restrictiveness, optimal standards, and the welfare results when all countries impose their optimal standard relative to a "laissez faire" world. These correspond to the results in Figure 4.

Table 8: Summary Stats for Counterfactual and Welfare Relative to Laissez Faire

Country	λ_{jj}	g_{jj}	g_{jj}^{opt}	t^{opt}	% ΔW (All)	% ΔW (Only j)	Ratio All/Only
BOL	0.456	1.328	1.166	1.312	0.0290	0.00200	14.50
CHL	0.576	1.066	1.256	1.337	0.0310	0.0130	2.385
COL	0.813	1.028	1.446	1.395	0.100	0.0930	1.075
CRI	0.192	1.175	1	1.172	0.0380	0	.
DNK	0.599	1.080	1.059	1.344	0.00400	0.00100	4
DOM	0.713	1.097	1.372	1.374	0.0580	0.0480	1.208
ECU	0.647	1.097	1.315	1.359	0.0540	0.0270	2
ESP	0.692	1.274	1.349	1.376	0.0420	0.0380	1.105
GTM	0.750	1.110	1.398	1.383	0.0720	0.0610	1.180
MEX	0.681	1.333	1.326	1.377	0.0400	0.0360	1.111
NIC	0.431	1.010	1.140	1.290	0.0240	0.00100	24
PER	0.755	1.062	1.397	1.392	0.0740	0.0630	1.175
PRY	0.738	2.274	1.418	1.488	0.0580	0.0550	1.055
THA	0.663	1.550	1.336	1.395	0.0320	0.0300	1.067
URY	0.721	1.625	1.384	1.418	0.0550	0.0490	1.122
ZAF	0.576	1.846	1.283	1.403	0.0170	0.0120	1.417
Total	0.625	1.310	1.290	1.363	0.0455	0.0331	3.893

This table presents the welfare results described in the left side of Panel (A) in Figure 4. The first four columns summarize estimated λ_{jj}, g_{jj}, optimal standards (set at home) and optimal tariffs for each destination, j. In the cooperation case, each j sets g_{jj}^{opt}, which determines g_{ij}'s $\forall i \neq j$ by (25), in order to maximize welfare taking the initial values of all other countries as given. The non-cooperative case assumes j sets their optimal regulation and the rest of the countries do not. The last row is the ratio of the preceding two.

6.8 Robustness Results for Counterfactual

We make use of the *TradeProd* database provided by CEPII which includes data on manufacturing gross output as well as a productivity measure, value added per worker, which can be used to approximate c_i (its inverse), and an estimate of wages (the total wage bill in manufacturing divided by employment). The downside of the data is that it is only provided up until 2006[58], and of course our measures of wages and costs likely contain large measurement error. With this data we conduct two separate robustness exercises. First, we re-run the analysis above, only altering trade shares by employing the 2002 trade and production data reported in *TradeProd* (for 13 countries plus ROW). The same estimated restrictiveness

[58] In fact to get a as large a sample as possible, we go back to 2002, and must drop Dominican Republic, Guatemala, and Nicaragua which are unavailable. In Section 2 as well as in the analysis above we use 2012 data.

produced with the 2012 EDD data are employed. We re-compute the trade shares and the associated wages and income to run the counterfactual.

In a more extensive alternative test, we also re-estimate g_{jj} with value added per worker and an estimate of the wage bill. Notice that instead of relying on (25), which requires us to use Chile as a reference country, it is more direct to estimate restrictiveness with (23). In this case, we assume costs (as the inverse of value added per worker) and wages can be observed in the data (with likely measurement error) to back out domestic restrictiveness given $g_{ij}, i \neq j$. Not requiring Chile as a reference country slightly broadens the data coverage, so we re-estimate non-domestic g_{ij} with earlier EDD data for a larger pool of countries.[59] Some details on the procedure and results are relegated to Appendix 6.8. With re-estimated restrictiveness measures, we then re-compute trade shares to run the counterfactuals.

More details are provided in the subsections below, but first we summarize the results for each of the two robustness exercises described above.

Figure 15 replicates Figure4 with the two alternative data exercises (Tables 9 and 10 replicate Table 8 from the appendix as well) – panel (A) reports the case where we re-compute trade shares with a new data set and panel (B) reports the case where we conduct the more extensive alternative test. For each, we show results for: i) welfare gains when all countries impose standards together and one at a time (relative to no standards), and ii) welfare gains for all countries imposing optimal standards and all countries removing tariffs completely, both relative to current policy. In panel (A), there are some small deviations in welfare effects, mostly due to differences in the domestic consumption share. The ranking of countries in terms of welfare gains changes slightly with the trade share although qualitatively the conclusions above hold.

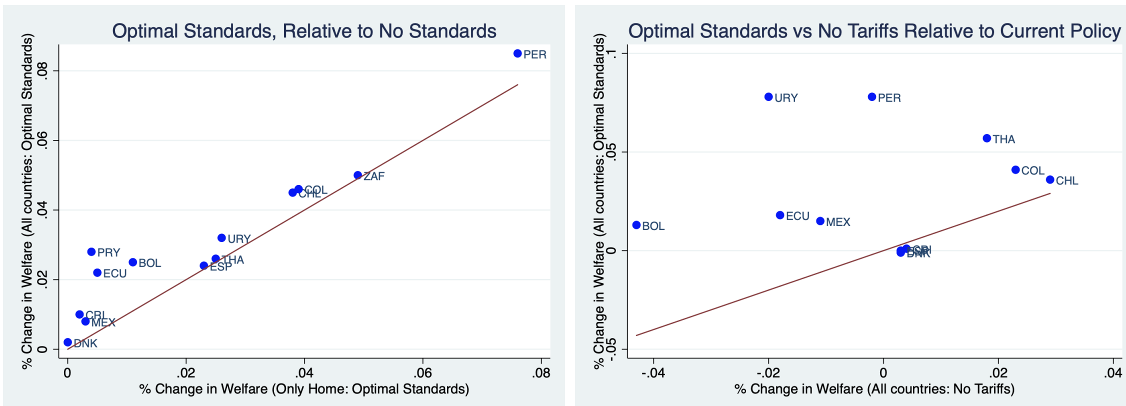
In the re-estimation of the restrictiveness values in the second exercise (panel (B)), one conclusion is that the previous strategy tends to under-estimate current domestic restrictiveness (see Table 10 for the full results on estimated restrictiveness and optimal policy). In many cases, we now find that initial domestic restrictiveness is *too high*. Optimal standards also rise, so welfare gains relative to no standards are also higher, which are the welfare gains we present in the left part of Figure 15 panel (B). The gains from all countries setting optimal standards unilaterally (but jointly) are now on average 10 times higher than countries doing so individually, and generally we observe larger possible welfare gains in this exercise. The ranking across countries of potential gains also changes, suggesting important differences in terms of the data that is applied. In the right figure, welfare gains seem higher

[59] Although it is not possible to go back to 2002, for each exporter in the EDD database we take its first year of data (between 2004 and 2008). Also, since we use wage data, we do not back out wages from gravity, but instead use the *TradeProd* data for both wages and trade shares.

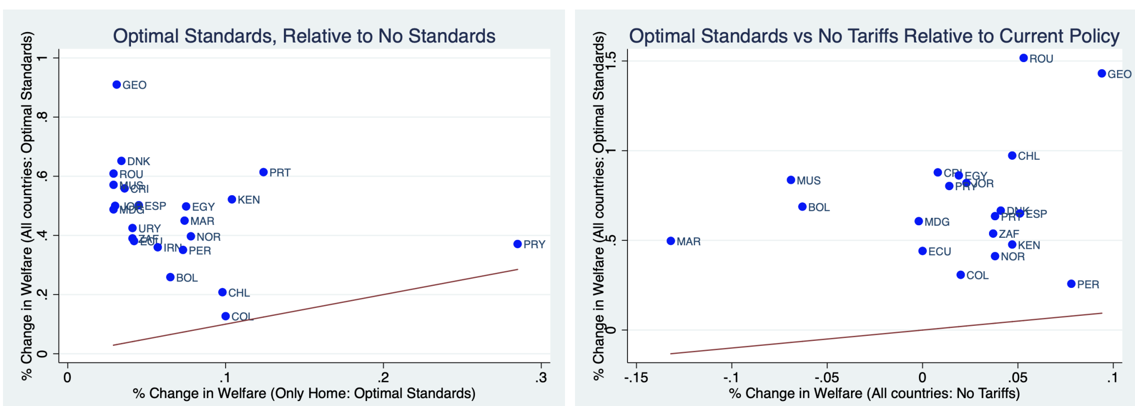
for some countries whose current restrictiveness is very large and therefore benefit greatly from lowering restrictions.[60] However, the main message from the previous results still hold: there appears to be a clear case for cooperation in setting standards, and the potential gains from moving standards away from the *current* policy are larger than the gains from removing all tariffs for all countries.

Figure 15: % Change in Welfare Robustness Results

(A) Alternative Data for Gross Output to Produce Trade Shares



(B) Alternative Data for All Initial Values



Both figures display the % change in welfare for countries in the two of the scenarios described in Figure 4, in this case using an alternative dataset – *Trade Prod, from CEPII.* This includes data on manufacturing gross output as well as a productivity measure, value added per worker, which can be used to approximate c_i (its inverse), and an estimate of wages (the total wage bill in manufacturing divided by employment). We detail how the restrictiveness measures are re-estimated in Appendix 6.8.2. In Panel (A), we re-run the analysis above with 2002 trade and production data reported in *TradeProd* (for 13 countries plus ROW), but keep the same estimated restrictiveness produced with the 2012 EDD data. In Panel (B), we re-estimate g_{jj} with value added per worker and an estimate of the wage bill, where we rely on (23) instead of (25). The sample of countries is extended and EDD data reflects earlier years. In both panels, the left figure compares welfare gains from setting optimal standards (relative to no standards at all) if all countries change their standards (y-axis) with welfare changes for each country when only that particular country raised its standards to the optimal one while all other worldwide restrictions were fixed (x-axis). The figures on the right compare the cases of moving to optimal standards and removing all tariffs, each relative to the current policy. In Panel (B), Uganda, Uruguay, and Iran are dropped to remove the presence of outliers, but can be found in Table 10.

[60]Some of this is not shown in the figure since we remove outliers to better present the results. Iran is the most extreme case, where welfare increases by almost 10%.

6.8.1 Re-compute Trade Shares with new Gross Output (Same Sample)

To check the impact of using trade and production data for 2002 instead of 2012, we re-run the analysis above with 2002 trade and production data reported in *TradeProd* (for 13 countries plus ROW), but keep the same estimated restrictiveness produced with the 2012 EDD data. Given new trades shares, wages are re-computed with the same method that leverages the market clearing condition. The correlation for wages is 0.30, while the correlation for the estimated optimal restrictiveness given the two samples is 0.64.[61] The main welfare results are presented in the main text, in panel (A) of Figure 15. Below, Table 9 presents the summary stats of optimal restrictions and trade shares in this scenario, along with the welfare gains in the case where countries impose their optimal standards relative to no policy.

The welfare gains, both from countries unilaterally setting their standards one at a time or all at once, are similar to the benchmark exercise. There is variation across countries, which suggests there are some important effects from the choice of data source. However, we see similar qualitative welfare implications from standard policy relative to the benchmark case.

Table 9: Summary Stats for Counterfactual and Welfare Relative to Laissez Faire (Alternative Gross Output)

Country	λ_{jj}	g_{jj}	g_{jj}^{opt}	% ΔW (All)	% ΔW (Only j)	Ratio All/Only
BOL	0.564	1.328	1.254	0.0250	0.0110	2.273
CHL	0.688	1.066	1.346	0.0450	0.0380	1.184
COL	0.692	1.028	1.347	0.0460	0.0390	1.179
CRI	0.469	1.175	1.192	0.01000	0.00200	5.000
DNK	0.363	1.080	1.045	0.00200	0	.
ECU	0.510	1.097	1.217	0.0220	0.00500	4.400
ESP	0.637	1.274	1.297	0.0240	0.0230	1.043
MEX	0.485	1.333	1.188	0.00800	0.00300	2.667
PER	0.782	1.062	1.424	0.0850	0.0760	1.118
PRY	0.510	2.274	1.249	0.0280	0.00400	7
THA	0.643	1.550	1.318	0.0260	0.0250	1.040
URY	0.646	1.625	1.324	0.0320	0.0260	1.231
ZAF	0.722	1.846	1.392	0.0500	0.0490	1.020
Total	0.593	1.364	1.276	0.0310	0.0232	2.430

This table presents the welfare results described in Panel (A) in Figure 15. The first three columns summarize estimated λ_{jj}, g_{jj} and g_{jj}^{opt} for each j. In the "unilateral but joint" case, each j sets g_{jj}^{opt} , which determines g_{ij}'s $\forall i \neq j$ by (25), in order to maximize welfare taking the initial values of all other countries as given. The non-joint case assumes j sets their optimal regulation and the rest of the countries do not. The last row is the ratio of the preceding two.

[61] We find a large correlation in trade shares across samples, equal to 0.96.

6.8.2 Re-estimation of g_{jj} with TradeProd Data

The *TradeProd* data also contains a productivity measure, value added per worker, which can be used to approximate c_i (its inverse), as well as an estimate of wages (the total wage bill in manufacturing divided by employment). With these two new pieces of information, consider an alternative estimate g_{jj}, that does not require using Chile as the reference country as above, but continues to rely on (23). In this case we assume that costs and wages are measured in the data with accuracy.[62]

Importantly, we now re-estimate g_{ij}, with two important differences in the sample: first, the sample coverage is expanded slightly; second, we use earlier EDD data, although it is not possible to go back to 2002. For each exporter in the EDD database we take its first year of data (between 2004 and 2008).

After estimating g_{ij} using the same procedure as before, we back out g_{jj} from (23)[63], and combine these with trade shares and wage data to conduct counterfactuals as in the benchmark exercise, computing optimal standards and tariffs for each country given parameters and country characteristics.

Table 10 reports some useful statistics as well as the welfare gains relative to laissez faire policy, where the sample has been extended given that we don't have to drop countries that do not act as destinations for Chile. There are some differences that emerge from re-estimating the restrictiveness values. One conclusion is that the previous strategy tends to under-estimate domestic restrictiveness. In many more cases, we now find that initial domestic restrictiveness is *too high*. This is why in the right part of panel (B) in Figure 15, the welfare gain of moving to optimal standard policy (from the current one) can be quite large. This is especially true in Iran (not available in our previous sample), where welfare increases by almost 10% by simply reducing its restrictiveness to the optimal value.[64]

However, notice that the gains shown in Table 10 and the left part of panel (B) in Figure 15 do not incorporate current restrictiveness as they measure welfare relative to no standards at all. Relative to the benchmark case, this procedure yields larger welfare gains of optimal standards relative to laissez faire. The gains to joint action once again exist, and are mostly larger.

[62]Since we use wage data here, we will not back out wages from gravity, but instead use the *TradeProd* data for both wages and trade shares.

[63]We once again estimate trade costs using coefficients from distance, etc. and furthermore, we require an estimate of α. We have generally found that how fixed costs are paid is not important, and in this case we set $\alpha = 1$ to look at the case where they are paid with domestic wages.

[64]This is not shown in the figure. We took out outliers where welfare changes were too large to more clearly report the rest of the countries.

Table 10: Summary Stats for Counterfactual and Welfare Relative to Laissez Faire (Alternative Gross Output)

Country	λ_{jj}	g_{jj}	g_{jj}^{opt}	% ΔW (All)	% ΔW (Only j)	Ratio All/Only
BOL	0.564	1.925	1.373	0.259	0.0650	3.985
CHL	0.688	2.156	1.445	0.208	0.0980	2.122
COL	0.692	1.738	1.431	0.127	0.100	1.270
CRI	0.469	1.807	1.185	0.559	0.0360	15.53
DNK	0.363	1.300	1.093	0.652	0.0340	19.18
ECU	0.510	1.636	1.276	0.381	0.0420	9.071
EGY	0.488	1.801	1.282	0.498	0.0750	6.640
ESP	0.637	1.584	1.173	0.502	0.0450	11.16
GEO	0.144	2.115	1.087	0.910	0.0310	29.35
IRN	0.618	4.687	1.428	0.360	0.0570	6.316
JOR	0.403	1.762	1.158	0.500	0.0300	16.67
KEN	0.827	1.538	1.367	0.522	0.104	5.019
MAR	0.526	1.527	1.288	0.450	0.0740	6.081
MDG	0.557	1.592	1.043	0.488	0.0290	16.83
MUS	0.475	1.749	1.070	0.571	0.0290	19.69
NOR	0.448	1.311	1.336	0.397	0.0780	5.090
PER	0.782	1.446	1.356	0.351	0.0730	4.808
PRT	0.497	1.300	1.080	0.614	0.124	4.952
PRY	0.510	1.728	1.576	0.371	0.285	1.302
ROU	0.549	2.026	1.085	0.609	0.0290	21.00
UGA	0.523	1.250	1.580	0.844	0.807	1.046
URY	0.646	3.250	1.313	0.425	0.0410	10.37
ZAF	0.722	1.704	1.210	0.390	0.0410	9.512
Total	0.550	1.867	1.271	0.478	0.101	9.869

This table presents the welfare results described in Panel (B) of Figure 15. The first three columns summarize estimated λ_{jj}, g_{jj} and g_{jj}^{opt} for each j. In the "unilateral but joint" case, each j sets g_{jj}^{opt} , which determines g_{ij}'s $\forall i \neq j$ by (23), in order to maximize welfare taking the initial values of all other countries as given. The non-joint case assumes j sets their optimal regulation and the rest of the countries do not. The last row is the ratio of the preceding two.

6.9 Other Results: Estimating Trade Shares from the Model

An alternative to using λ_{ij} from the data is to predict trade shares with the structure of the model. Although this is more theoretically consistent, it also leads to some improbable trade shares, and for that reason we stick to the data in the benchmark analysis.

$$\ln \frac{\lambda_{ij}}{\lambda_{jj}} = \underbrace{\ln \left[J_i b_i^{\kappa} (c_i w_i)^{-\kappa+\gamma+1}\right]}_{\text{Origin FE}} - \underbrace{\ln \left[J_j b_j^{\kappa} (c_j w_j)^{-\kappa+\gamma+1}\right]}_{\text{Destination FE}} - (\kappa-\gamma-1) \ln \frac{\tau_{ij}}{\tau_{jj}} + \ln \left(\frac{g_{ij}^{-\kappa} G_2(g_{ij})}{g_{jj}^{-\kappa} G_2(g_{jj})} \right), \tag{46}$$

where trade costs take an explicit form as as above (distance, etc.) plus an indicator for internal trade, and the last component is produced with estimated restrictiveness measures. Then, the measure of trade shares is the predicted value of $\frac{\lambda_{ij}}{\lambda_{jj}}$, which includes domestic shares that are produced with the approximated manufacturing gross output described above.

Table 11 displays the results for trade shares if we were to back them out after estimating the gravity equation, instead of taking them straight from data.

Table 11: Predicted Trade Shares

	BOL	CHL	COL	CRI	DNK	DOM	ECU	ESP	GTM	MEX	NIC	PER	PRY	THA	URY	ZAF
BOL	0.752	0.002	-	-	-	-	-	-	-	-	-	0.005	-	-	-	-
CHL	0.076	0.973	0.005	0.006	0.001	0.004	0.004	0.001	0.003	0.002	0.008	0.030	0.008	0.000	0.019	0.001
COL	0.022	0.003	0.948	0.022	-	0.017	0.023	0.002	0.007	0.002	0.022	0.029	0.002	-	0.004	-
CRI	-	0.000	0.001	0.870	-	0.003	0.001	0.000	0.002	0.001	0.061	0.002	-	-	0.000	-
DNK	0.004	0.000	0.001	0.002	0.990	0.003	0.001	0.002	0.000	0.001	-	0.002	-	0.000	0.001	0.001
DOM	-	-	0.001	0.001	-	0.907	-	0.000	0.001	0.000	-	-	-	-	-	-
ECU	0.004	0.001	0.010	0.006	-	0.005	0.939	0.001	0.002	0.000	-	0.018	-	-	-	-
ESP	0.025	0.005	0.007	0.013	0.004	0.016	0.006	0.980	0.005	0.004	0.029	0.013	0.006	0.001	0.010	0.005
GTM	-	0.000	0.001	0.008	-	0.004	0.001	0.000	0.907	0.003	0.035	0.001	-	-	-	-
MEX	0.045	0.006	0.015	0.049	0.002	0.035	0.013	0.008	0.067	0.983	0.163	0.023	0.007	0.001	0.016	0.004
NIC	-	-	-	0.011	-	-	-	-	0.002	0.000	0.665	-	-	-	-	-
PER	0.039	0.004	0.007	0.005	-	0.004	0.009	0.001	0.002	0.001	0.011	0.868	0.002	-	0.004	-
PRY	0.017	-	-	-	-	-	-	-	-	-	-	-	0.968	-	0.009	-
THA	0.009	0.002	0.003	0.007	0.002	0.003	0.003	0.003	0.003	0.002	0.005	0.006	0.003	0.998	0.007	0.006
URY	0.007	0.002	0.001	-	-	-	-	0.001	-	0.000	-	0.001	0.005	-	0.930	-
ZAF	-	0.001	0.001	-	0.000	-	-	0.001	-	0.000	-	0.002	-	0.000	-	0.982

This table reports λ_{ij}'s when we use the estimated relationship given by (46). The specification is run with gravity data and the restriction parameters estimated in the previous step.